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BONE CHANGES IN CHRONIC FLUORINE INTOXICATION

A ROENTGENOGRAPHIC STUDY

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WHILE fluorine is not a constituent of bodies of new-born animals and humans, it is so universally present in later life that in small amounts it is considered normal. Its presence is due to two important facts—the inevitable ingestion of small quantities of fluorine salts in food and water and the incomplete elimination of them. Fluorine is one of the most widely distributed elements in nature. It is present in much of the soil and in the vegetation of such soil, as well as in the water of many springs and streams. It is also almost universally present in sea water and consequently in many of the edible forms of marine life. With a single exception, investigators are in agreement that fluorine has no important useful biological function. Much work has been done on this subject in recent years, as indicated by an exhaustive review by DeEds[4] which has 138 articles listed in the bibliography. I have taken the liberty of drawing freely from this excellent study in assembling general facts of importance in relation to our subject.

Evidence is accumulating to show that there is an increasing liability to the ingestion of still larger amounts of fluorine, due to disturbance of natural distribution of the more concentrated forms of fluorine in minerals and ores as a result of the industrial and agricultural activities of our present civilization. It would seem that DeEds is amply justified in warning us that the public health aspects of fluorine in industrial hygiene, agriculture and foods is becoming an increasing problem. There is no clinical or experimental evidence at hand to indicate that the inhalation of dust containing fluorine salts or gas is responsible for general toxic symptoms or bone changes. Flemming-Møller and Gudjonsson[5] were unable to demonstrate bone changes in 21 workers who were subjected to the inhalation of fluorine fumes in glass, enamel, and sulphuric acid industries.

Since chronic intoxication is the result of the ingestion of very minute quantities, as little as 0.1 mg. per kilo of body weight per day over a long period of time, and since the possibility is so widespread, a review of the sources of contact of man with toxic amounts should be of interest.

Cryolite is an ore used extensively as a source of aluminum, alum, and caustic soda. It is a fluoride of sodium and aluminum containing as much as 54 per cent of fluorine and a small amount of quartz. From the mining of the ore, principally in Scandinavia and Canada, workers who handle it are exposed to the hazard of swallowing some of the dust. The findings of Flemming-Møller and Gudjonsson who

examined a group of such workers will be presented in the discussion of bone changes.

Cristiani and Gautier[3] have shown that during the process of refining cryolite sufficient fluorine gas is discharged into the air to cause an increase in the fluorine content in the vegetation in the neighborhood. They have shown that cattle grazing on this vegetation develop a cachectic condition, and that guinea pigs fed on hay grown in the vicinity die of cachexia in a few weeks to several months. The bones of such animals showed an increased fluorine content.

In the United States, phosphate rock is used extensively in the manufacture of superphosphate fertilizers. This rock contains, on an average, 4 per cent of fluorine. Here again, workers are liable to the ingestion of small amounts of the rock dust. A case showing marked bone changes in a worker who handled this powdered rock is the basis of this paper.

During the conversion of this raw rock phosphate into superphosphates only about 25 per cent of the fluorine is lost as a gas. Reynolds, Ross and Jacobs[8] estimate that, because of the remaining 75 per cent in the finished fertilizer, a total of 90,000 tons of pure fluorine is added to the cultivated soil of this country each year. It seems probable that vegetation grown on soil which has been repeatedly fortified by the addition of such fertilizers will contain increasing quantities of fluorine. Rock phosphate has been used extensively as a source of phosphates in the manufacture of baking powder. Such powders frequently contain perceptible amounts of fluorine.

Fluorine compounds are frequently used as insecticides and for fumigating purposes. The obvious danger of contamination has led DeEds to advise that the use of fluorine in connection with foods and plants be limited to conditions where satisfactory removal of the fluorine residue can be carried out before the food is placed on the market.

Fluorine is also widely distributed in water. Churchill[2] demonstrated its presence in the municipal water supplies of Cincinnati, Milwaukee, Birmingham, Pittsburgh, St. Louis, Kansas City, Toledo, Cleveland, Detroit, Peoria, Indianapolis, Buffalo, Davenport, San Francisco, Minneapolis and Los Angeles. Mottled discoloration and pitting of tooth enamel are commonly noted in eighteen states in this country, and in similar areas on all of the continents. Such a condition has been observed by the author in a boy who has lived his entire six years in Detroit, Toledo and Cleveland. Smith, Lantz and Smith[10] examined the teeth of the inhabitants of St. Davids, Arizona, where the water supply contains considerable fluorine. They found mottling of the teeth in all of those persons who had lived in the community through the period when enamel was being laid down on the permanent teeth. Those who came to the town after the formation of their permanent teeth showed no such defects. A few who had arrived during the period of erupting teeth showed it only in the teeth that were formed after their arrival.

The most evident general symptoms of chronic fluorine intoxication, in addition to dental defects, are, according to DeEds, loss of weight, impairment of growth in young individuals, loss of appetite, and cachexia. The damage done to the individual outlasts the period of exposure, and recovery is never complete. He does not mention bone changes in man except to say that the consensus is that very small doses may produce no symptoms but that there is incomplete elimination of fluorine, indicating storage within the body, largely in the bones and teeth.

A most significant experimental study was reported by Brandl and Tappeiner[1] in 1891. A dog was fed sodium fluoride in increasing doses from 0.1 to 1.0 gm. per twenty-four hours. At first none was eliminated. It was not until a certain accumulation had occurred and the daily dose had gone beyond 0.5 gm., that excretion did occur. The animal remained well except for occasional attacks of nausea and diarrhea

during the higher dosage period. These symptoms were relieved by temporarily lowering the dose. It did develop a peculiarly stiff way of holding its back. After being fed a total of 402.9 gm. of sodium fluoride over a period of twenty-one months the dog died of accidental coal gas poisoning. The blood, liver, and kidneys showed no change of structure and no concretions. The bones, the muscles with their ligamentous attachments, and the fibrocartilages all showed definite changes. The bones were chalky white and brittle but hard and difficult to break. Microscopic examination showed the bone structure intact but the haversian canals were so completely filled with the shiny octahedral crystals of calcium fluoride that it seemed remarkable that there was still any room for the capillaries. During the experiment 330.5 gm. of sodium fluoride had been recovered from the urine and feces. After death 64.64 gm. (all but 1.9 per cent of the remainder) was recovered from the body, largely from the bones and teeth. This experiment has been confirmed by Rost,[9] McClure and Mitchell,[6] and others. Stanton and Kahn[11] have also reported the presence of calcium fluoride crystals in the bones of animals after fluorine feeding.

The exact nature of the process which results in the storage of fluorine in bone is not known. It is apparently the result of a disturbance of the whole complex mechanism of bone metabolism. It is hoped that the future studies of Flemming-Møller and Gudjonsson on their large series of cases, and additional chemical studies by Dr. Wolff of the bones in our case will, when completed, throw some light on this interesting subject.

From a practical viewpoint it appears that after the ingestion of fluorine salts, the most of which are readily soluble, a certain amount is absorbed and eventually converted into calcium fluoride which is practically insoluble. The chemical process and the tissues in which it occurs are not known but, in contact with bone, calcium fluoride is deposited with other calcium salts in the bone. Being insoluble, the calcium fluoride remains and accumulates instead of being eventually eliminated from the body as a part of the usual interchange of old and new calcium salts that takes place in normal bone metabolism. It would seem that only that part of the fluorine which is not combined with calcium is eliminated. Evidence indicates that a low calcium intake hastens the onset and development of symptoms of chronic fluorine intoxication, while a liberal calcium intake tends to offset those effects. Pierle[7] and Toverud[12] have shown that abnormal teeth may result from the ingestion of relatively large amounts of fluorine when combined with a normal amount of calcium, or that they may occur after a diet containing a small amount of calcium combined with a normal amount of fluorine. An adequate calcium intake seems to prevent the usual action of fluorine on the teeth as well as the development of general toxic effects. It is probable that calcium acts as a sort of buffer substance with relation to fluorine, that its rôle is one of fixation of the fluorine by the formation of insoluble calcium fluoride which is stored in the bones, thus rendering it relatively non-toxic to the organism as a whole.

This theory would explain the absence of general toxic symptoms in our case, where the rate of fluorine intake was very low and in combination with a relatively high calcium intake of the average normal diet of a laboring man. This is in contrast with the following group of cases in which the fluorine intake was higher with definite acute as well as chronic effects.

We are indebted to Flemming-Møller and Gudjonsson[5] for the first roentgenographic demonstration of the bone changes in chronic fluorine intoxication in humans. These changes were observed while making a survey of silicosis among 78 men who had worked for varying periods of time in the presence of cryolite dust (54 per cent fluorine). In addition to general ill health, as evidenced by the fact that these men could remain at this work for an average

Fig. 1. Normal spine of man same size and weight as Figure 3.

of only ten years, they report four groups of changes among them:

(1) *Silicosis*, first and second stages, in half (39 cases) of the workers as a result of the inhalation of dust of this ore which contains quartz.

(2) *Stomach affections* which were found to be acute in over half of the men (42 cases). The symptoms, nausea, vomiting and loss of appetite, appeared soon after the men began to work in the dust-laden atmosphere and disappeared shortly after they returned to fresh air. These symptoms were found to be due to gastric irritation from swallowing the dust (fluorine intoxication) and were not related to inhalation of the dust.

(3) *Anemia*. A low red cell count with a high hemoglobin was found in the group showing the most extensive bone changes. The authors suggest that this is a result of destruction of bone-marrow.

(4) *Bone changes* of varying degrees were found in 30 of the 78 men examined. The changes varied from "fleecy thickening of the bone lamina and an increase in the whiteness of the bone shadows on the roentgenogram" to an actual opacity of the bones and calcification of the ligamentous attachment. These abnormalities were found to be roughly proportionate to the length of employment in this work. Their detailed description of the roentgenographic appearance of the bones is recommended as a classic.

As Flemming-Møller and Gudjonsson point out, none of the experimenters on record have made use of roentgenograms to demonstrate or record the bone changes that they have produced and described. In presenting their roentgenographic description they state, "we nevertheless find exactly reflected in the cryolite workers examined by us, all of the symptoms there described as resulting from the ingift of fluorine salts—both the clinical onset and those patho-anatomical ones with respect to bones, ligaments and fibrocartilages. So far as it is possible to be at all certain at

Fig. 2. Normal spine of man same size and weight as Figure 4.

present, we therefore venture to conclude that the osseus changes observed in these cases are due to the fluorine contained in the cryolite."

It is our privilege to add another case to their group, similar in history of ingestion of fluorine salts, identical in the appearance of the bone change on roentgenograms; and to confirm their theories by presenting for the first time proof as to the etiology of the bone changes, a preliminary report on the fluorine content of various bones.

CASE REPORT

As with the group reported by Flemming-Møller and Gudjonsson, our case was found by accident. The unusual size and density of the bones of the thorax were noted during a routine roentgenoscopic examination of the heart and lungs of a colored man, aged forty-eight, who was suffering with luetic heart disease. The peculiar changes shown on films that were made of his entire skeleton were unlike any we had seen. The widespread sclerosis or bone condensation, most extensive in the trunk, suggested the osteoplastic form of metastasis of carcinoma of the prostate. The extreme density of the vertebral bodies brought up the possibility of "marble bones." The former opinion was accepted by several competent roentgenologists who studied the films. The clinical findings, however, did not support this diagnosis. The prostate was small and smooth, the general condition of the patient and the clinical findings were entirely those of the heart disease. With the exception of slight limitation of motion of the lower lumbar spine, there was no clinical suspicion of skeletal involvement.

Fig. 3. Bone changes of chronic fluorine poisoning. Compare with Figure 1. Note increased bone density, normal bone trabeculation and spicule formation along anterior iliac margins and external pubic borders.

Fig. 4. Bone changes of chronic fluorine poisoning. Compare with Figure 2. Note homogeneous density of vertebral bodies and the presence of large osteophytes which have the same high fluorine content as the vertebral bodies.

The careful history taken by a medical student first revealed the fact that the patient had been employed for eighteen years in a fertilizer factory where he had handled finely ground rock phosphate. In following this lead, for possible disturbance of phosphorus metabolism, we found that rock phosphate contains an average of 4 per cent of fluorine and the identity of the condition was recognized. There was no history of gastric disturbances and no residual systemic effects of chronic fluorine intoxication.

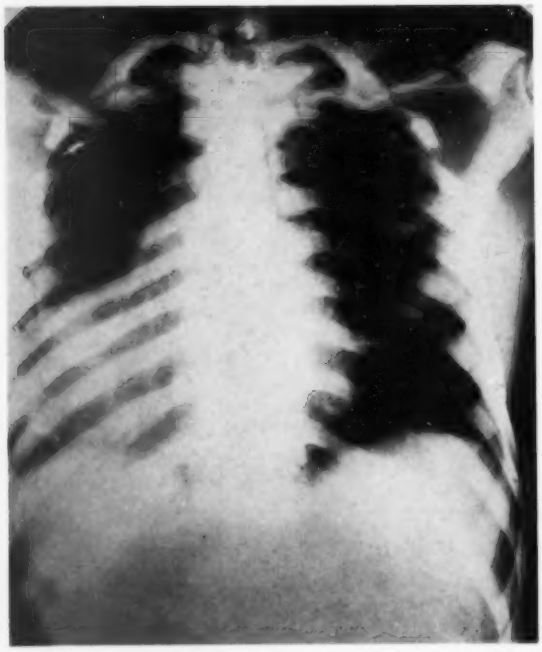

FIG. 5. Bone changes of chronic fluorine poisoning. Note density of ribs and scapulae and the enlargement of the inferior ridges of the ribs, posteriorly.

We feel that this can be explained by the extremely low fluorine intake in combination with an adequate calcium intake. There was no anemia and the blood calcium and phosphorus determinations were normal.

Autopsy Findings. The patient died on April 5, 1935, thirteen and a half months after the roentgenographic study. He had not returned to work or been otherwise exposed to the ingestion of fluorine during this interval. The postmortem examination disclosed changes typical of luetic heart disease, which was established as the cause of death. Chronic passive congestion was found in the lungs, liver, and kidneys. There were no gross or microscopic calcium deposits in any of the organs. The gall-bladder contained several mulberry calculi which were not radiopaque. The gastrointestinal tract was normal throughout. There was no glandular adenopathy.

Skeleton. The ribs were difficult to cut because of increased density. The cortex was thickened with encroachment on the marrow space. The cortical portion of all the long bones of the extremities was of great density. It was somewhat thicker than normal, at the expense of the marrow cavity. The bodies of the dorsal and lumbar vertebrae were increased in density and contained less marrow than usual. The bones of the skull did not appear to be increased in thickness or density. Great difficulty was encountered in decalcifying the bones for microscopic study. Sections of ribs and vertebrae were most satisfactory. They revealed very dense osteoid tissue. Only a small amount of marrow tissue remained and this appeared normal. There was no evidence of bone destruction or abnormality of bone structure.

The fluorine content of several specimens of bone, as determined by the method described by Willard and Winter,[13] is shown in the following table. These figures indicate an abnormally high fluorine content of the bones which is in direct proportion to the extent of the changes as shown on the roentgenograms. Additional and more complete chemical analyses, with special reference to the calcium and phosphorus content, are being made at this time by Dr. William A. Wolff, who will make a subsequent report of his findings.

ROENTGENOGRAPHIC APPEARANCE

The essential changes are an increase in bone density without alteration of normal

FIG. 6. Bone changes of chronic fluorine poisoning. Note increase in bone density and osteophyte formation at muscle attachments and long interosseous ridge.

TABLE I

FLUORINE DETERMINATIONS

I. Analysis of phosphate rock
Fluorine 3.43 per cent (preliminary value)

II. Controls on normal bone, center of femur
Fluorine 0.076 per cent
(Literature gives 0.03–0.07 per cent fluorine)

III. Analysis of bone from Case W. J. Necropsy No. 5256

Femur, center	0.29% fluorine
Skull, upper parietal	0.37% fluorine
Rib, 2nd or 3d	0.56% fluorine
Sternum, manubrium	0.69% fluorine
Vertebra, lumbar (medulla)	0.70% fluorine
Vertebra, lumbar (cortex)	0.67% fluorine
Vertebra, lumbar (osteophyte)	0.68% fluorine

bone structure, lack of nomal sharpness of the bone outlines, and extension of calcification into ligamentous attachments. These features combine to give one the impression that the roentgenograms have been made with a very broad focus tube operating at too low voltage. Repeated attempts failed to produce films with satisfactory bone detail and density.

FIG. 7. Bone changes of chronic fluorine poisoning. Note bone density and calcification of attachment of muscles and interosseous membrane.

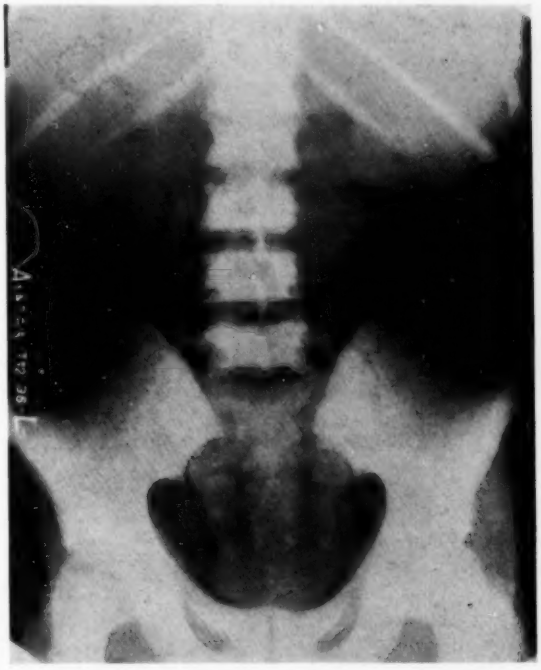

FIG. 8. Osteoplastic metastasis of carcinoma of prostate. Compare with Figure 3. Note mottled appearance due to areas of bone absorption adjacent to areas of sclerosis. Normal bone architecture has been lost.

The increase of bone density varies from slight blurring and accentuation of the trabeculations, "fleecy thickening of the bone laminae," in areas of early involvement, to marked homogeneous opacity, "milk white opacity," with obliteration of bone detail in the most advanced areas. The earliest changes appear in the trunk, especially in the spongy bone of the vertebrae and pelvis. As the condition progresses, the changes in these bones become more marked and the process extends toward the periphery, until in advanced stages the bones of the hands, feet, and skull are involved. The characteristic of this increase in density is the preservation of the normal osseous architecture. There is no bone destruction and no distortion or replacement of trabeculations. The appearance is one of normal bone structure, but of too much of it.

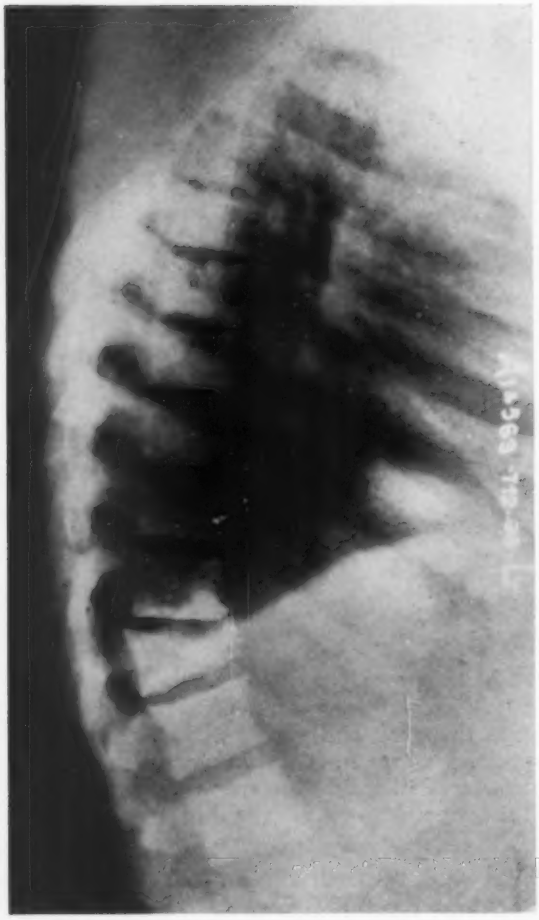

FIG. 9. Osteoplastic metastasis of carcinoma of prostate, same case. Compare with Figure 4. Note mottled appearance of vertebral bodies, the crush fracture and the absence of dense osteophytes.

The indistinct margins are the result of extension of calcification into the soft tissues at the attachments of ligaments and muscles. This, with the increase in density, gives the impression of marked enlargement of the bones. This is especially true of the ribs where the actual widening, due to the fringe of calcium deposit in the soft tissues along the ridges on the lower margins, is accentuated by the corresponding narrowing of the interspaces.

Osteophyte formation with calcification of the ligaments between vertebral bodies is marked. The large one between the bodies of the 3d and 4th lumbar vertebrae (Fig. 4) had the same high fluorine content as the bodies themselves. Complete bridging between vertebral bodies is frequent in advanced cases, which accounts for the stiffness of the back which is often present. In the pelvis the anterior iliac margins, the pubic and ischial borders, show roughening with extension of spicules into the soft tissues. Flemming-Møller and Gudjonsson mention increased calcification of the costal cartilages but in our case this was not present. The intervertebral and articular cartilages are not involved.

Differential diagnosis is of importance because of the difference in prognosis between this condition and the one with which it is most likely to be confused—osteoplastic metastasis from carcinoma of the prostate (Figs. 8, 9, and 10). They are similar in that both produce "sclerotic" bone changes, with the spine and pelvis most frequently and extensively involved.

In fluorosis the normal bone architecture, in spite of the increase in density, the uniformity of distribution of the density, the calcification of ligaments and the absence of a corresponding failure of general

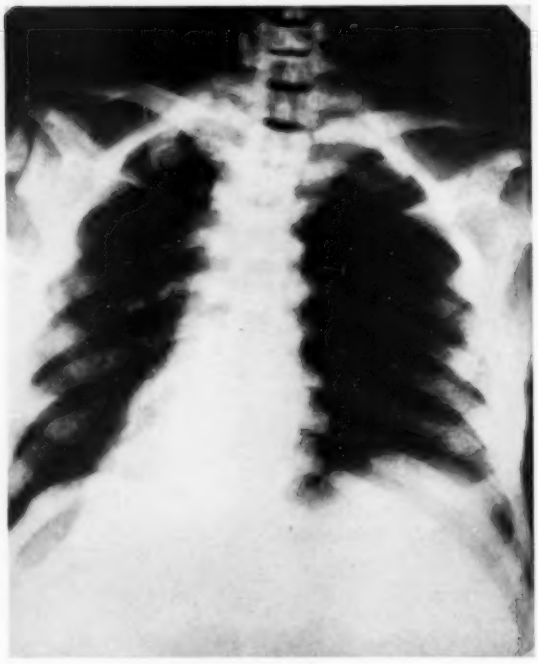

FIG. 10. Osteoplastic metastasis of carcinoma of prostate, same case. Compare with Figure 5. Note mottled appearance and lack of widening of ribs.

health, should indicate the benign nature of the condition. A history of long-continued exposure to fluorine ingestion may be difficult to obtain but will establish the diagnosis. In carcinoma of the prostate there is disturbance of bone structure; no matter how dense the sclerosis, areas of destruction can be identified. There is also less tendency to regularity of distribution of lesions.

I am indebted to the following members of the Staff of the Pennsylvania Hospital: Dr. David L. Farley, Chief of Medical A Service, and Dr. John T. Bauer, Director of the Ayer Laboratory, for their cooperation; to Dr. Joseph B. Vander Veer, Assistant Director of the Ayer Laboratory, who did the postmortem study, and to Dr. William A. Wolff, of the Department of Chemistry, who made the fluorine determinations.

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A ROENTGENOLOGICAL AND ANATOMICAL STUDY OF THE MAXILLARY SINUS*

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THE maxillary sinus, while subject to all of the variations common to the paranasal sinuses, presents a series of special anatomical and pathological conditions because of the close relationship which the teeth of the upper dental arch bear to the floor of this sinus. As a result, the interpretation of the roentgenograms of the maxillary sinus may be complicated by the

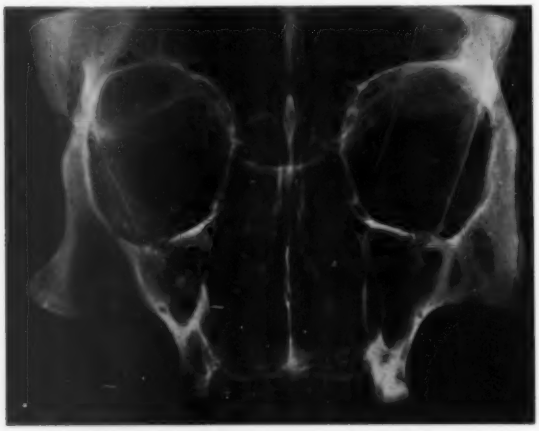

FIG. 1. Roentgenogram of tanned anatomical specimen, showing extensive resorption of alveolus, with the maxillary sinus above the floor of the nose.

overlapping of dental shadows. In a like manner, the investigation of the conditions about the root apices are complicated by the vascular patterns in the wall of the maxillary sinus. The major features of the development and the adult anatomy of the maxillary sinus are well known; there are, however, some clinically and roentgenographically significant details related to the floor of the sinus that have escaped sufficient notice.

The maxillary sinus is present at birth but, lying as it does in the maxilla together with the unerupted tooth buds, it is of very small size. We might say that the volume of the maxillary sinus and the volume of the unerupted tooth buds are of reciprocal size. When dentition is progressing at a normal rate of speed the maxillary sinus has expanded from its strictly infraorbital position to the level of the attachment of the inferior nasal turbinate. That is to say, its floor is opposite the middle nasal meatus. At puberty, or with the eruption of all of the teeth, with the exception of the third molars, the maxillary sinus has expanded to the level of the floor of the nose. This might be considered the minimum size for a normal adult maxillary sinus. The maxillary sinus usually continues to expand into the alveolus so that in the adult its lowermost portion is below the level of the floor of the nose.

There is a further modification of the maxillary sinus that to our knowledge has not been previously mentioned in the

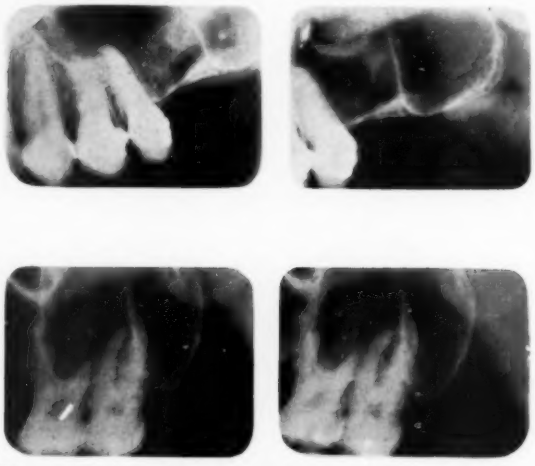

Fig. 2. Tuberosity extensions of the maxillary sinus. Two cases.

roentgenographic literature. This modification is concerned with the loss of the permanent teeth. With the loss of the teeth, and especially with the failure of their replacement with a denture or with the use

* Read at the Thirty-sixth Annual Meeting, American Roentgen Ray Society, Atlantic City. N. J., Sept. 24–27, 1935.

of an improper denture, the alveolar ridge recedes. With the recession of the bony alveolus the floor of the maxillary sinus ascends so that in edentulous senility the lowest part of the maxillary sinus lies again at the level of the floor of the nose. The alveolar recess has disappeared (Fig. 1).

In addition to the alveolar extension, there are other regularly recognized extensions or diverticula of the maxillary sinus. The extensions enumerated by Zuckerkandl are as follows: the infraorbital, the zygomatic, the alveolar (mentioned above), and the palatal. We wish to add a fifth, the tuberosity extension. The infraorbital extension is of roentgenographic significance because, when present, it occupies the area of the agger nasi ethmoidal cells and its shadow can probably not be separated from them in routine films. This

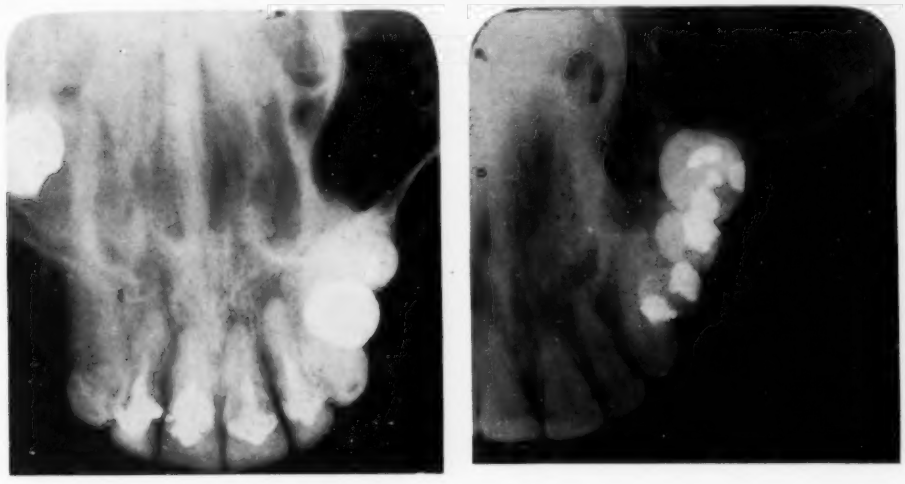

Fig. 3. Technique employed in intraoral examination of the maxillary sinus

Fig. 4. Films obtained by technique illustrated in Figure 3. The palatal extension of the maxillary sinus and the infraorbital foramen are well shown.

extension, lying as it does between the nasolacrymal duct and the infraorbital canal, is of more significance to the operating rhinologist than to the roentgenologist. It has also been described as the prelacrymal recess. The zygomatic extension requires no comment. The changes in the alveolar extension have already been noted. The palatal extension, when present, is of significance because of the possible confusion of this extension with cystic changes in the hard palate.

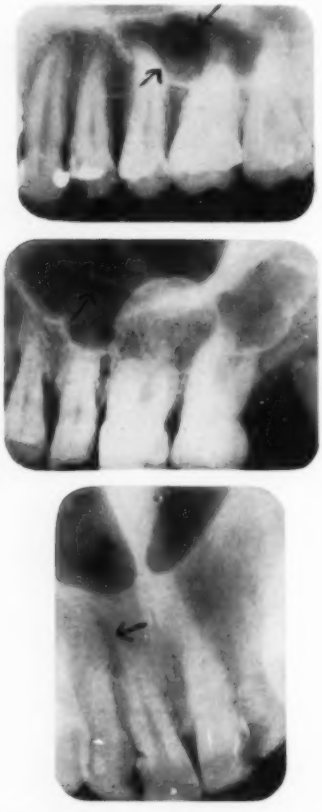

Fig. 5. Three cases of vascular canals confused with pathological change. The annular network is probably the most confusing. The arrows indicate the vascular markings.

The maxillary sinus may extend into the maxillary tuberosity. The tuberosity is that eminence of bone immediately posterior to the third molar tooth. The tuberosity is at times very large and bulbous and it is impossible to forecast the extension of the sinus into such a tuberosity without a roentgen examination (Fig. 2). In preparing a mouth for full dentures the surgical reduction of such bony prominences is sometimes carried out. Failure to investigate roentgenographically the possible presence of the sinus into these prominences has led to the opening of the sinus and the destruction of the very bone that should be preserved.

All of these details in the floor of the maxillary sinus may be best brought out by the use of intraoral films. In this way it is possible to secure detail with absence of overlapping shadows that cannot be obtained with the usual posteroanterior projections used for sinus films. The intraoral technique devised by one of us (Ennis) follows.

The patient is in the sitting posture with the head so tilted that the occlusal plane of the teeth is horizontal; an occlusal film is then placed in the mouth with the long axis of the film anteroposterior. The film is moved laterally until its one border is in the midline and the other border distends the cheek. This brings the film directly under the maxillary sinus. The central ray is directed to the infraorbital foramen in a parasagittal plane with the tube displaced 10 or 15 degrees forward from the vertical in order to avoid the overlapping of the supraorbital ridge (Fig.3). This is the technique of choice when examining for tooth fragments that may have been dislocated in the maxillary sinus. Differentiation of dental root cysts from palatal extensions of the maxillary sinus are also readily made by this technique (Fig. 4).

The greater detail obtained on the intraoral film brings up new problems in diagnosis. The posterior superior alveolar artery courses in the lateral wall of the maxillary sinus with its accompanying veins to the canine fossa, where it is joined by branches from the infraorbital canal. These bone channels give rise to confusing patterns, especially when projected over tooth structures. They are probably of more significance in dental films than in the intraoral sinus films (Fig. 5).

SUMMARY

The roentgen examination of the maxillary sinus is complicated by the presence of the upper dental arch. The special conditions here are best studied on intraoral films. Palatal cysts by this method are most readily differentiated from changes in the maxillary sinus and, likewise, details of the sinus extensions are best made out. The greater detail obtained on intraoral films makes particularly significant the vascular bony channels which have been variously diagnosed as pathological changes, both on intraoral sinus films and on dental films.

DISCUSSION

Dr. George Coates, Philadelphia. The points brought up in this paper are of great interest to me as a rhinologist and are the more convincing because Dr. Batson has the advantage, shared by few, among whom is Dr. Fred Law, of being not only a roentgenologist, but an anatomist and a practical rhinologist as well. He can therefore look upon diagnostic roentgenology from various angles, which places him in an excellent position for the study of these various shadows which may confirm or disprove a clinical diagnosis. We clinicians are accustomed to think of maxillary sinus pictures as being the easiest of diagnosis, but it seems evident, from its pyramidal shape and its several possible extensions, that this is not always the case. The position described for the study of the floor is a new one to me and I can easily see its possible advantages, particularly when it comes to the question of the discovery of lost tooth roots or other foreign bodies, such as pieces of broken instruments, which at times find lodgment in this cavity.

The idea that variations of the vascular pattern of the wall of the maxillary sinus could simulate pathological changes around the apices of the teeth is of great interest and certainly deserves careful study and consideration. We all know, I suppose, the development of the maxillary sinus, from its size and position at birth, to its adult form when in the vast majority of instances the floor of the sinus has descended below the level of the nasal floor. That after loss of teeth, this floor may reascend is not so well known or understood and where there is an edentulous mouth and this is not taken into consideration, confusion in the interpretation of roentgenograms may well occur.

We have seen the excellent plates that Dr. Batson has taken, showing that the floor of the maxillary sinus may dip downward after the removal of a tooth and this also may cause confusion in interpretation. A good understanding of these and the other points brought out by Dr. Batson is essential, not only to the roentgenologist in making a report of his findings, but also to the rhinologist and especially to the one who undertakes to interpret the film himself. That this interpretation by the rhinologist is a good thing, I am not prepared to state, but I do think that every rhinolgist should be trained, as well as possible, at least to recognize gross anatomical and pathological abnormalities. Unless he has studied roentgenology himself, the average man can hardly be expected to pass upon the finer points of diagnosis.

The last point brought out by Dr. Batson concerning the tuberosity of the maxilla and the possible extension of a diverticulum from the maxillary sinus into this tuberosity is, I think, entirely new. I was certainly not familiar with it from the clinical standpoint until it was pointed out to me by the author. It may be of very great clinical significance to the rhinologist and even more so to the dentist who attempts to level off this prominence and in doing so finds that a portion of the floor of the maxillary sinus has been removed, which would be quite a calamity.

There are a great many points of interest in this short paper that might well be discussed in more detail did time permit.

In conclusion, I would only say that I very much like the idea of making a study of the floor of the maxillary sinus by the intraoral method as just outlined to us. If we have this in addition to the plates taken from the usual positions, it seems to me that we will have a very comprehensive idea of the size of the sinus, its anatomical variations and a great deal of detail as to its possible pathology.

Dr. Ennis (closing). A statement in which I think we will all concur is that the examination of the maxillary sinus cannot be adequately done unless we take every available means to ascertain the conditions present. From a dental standpoint, one of the most common accidents happening in the extraction of teeth, especially in the molar and premolar

region, is the fracturing of the roots and in trying to recover that fractured portion, it is driven through the floor and into the maxillary sinus.

Unfortunately there are some individuals who allow these roots to remain in the sinuses. From the lateral view of the sinuses, residual roots cannot be found. I say that reservedly. If sometimes the root is very large, it may be seen, but not ordinarily. Therefore, this technique which has been described becomes of greatest importance as it shows the floor of the sinus where these roots lie. Very often we have case histories where there is chronic infection of the maxillary sinus. They have been treated and roentgenographed with no definite diagnosis of the cause of infection. With this type of examination we may more readily locate these residual roots.

For the purpose of interpreting cystic conditions, for often these cannot be seen in the posteroanterior or lateral view of the sinuses, we again resort to the technique of the occlusal film.

One of the most common cysts we find in the mouth is the ordinary dental root cyst, often found in the molar region. There is generally no direct communication with the maxillary sinus, as they push the floor of the sinus out of the way.

Downstairs we have an exhibit of a skull showing complete obliteration of maxillary sinus due to this type of cyst.

We often have the dentigerous cyst which comes from the dental follicle containing a tooth or part of a tooth. Very often they become of such size that they absolutely obliterate the maxillary sinus, even in this type of examination. However, we have here a normal anatomical landmark of definite diagnosis which we have not mentioned due to the shortness of the paper, and that is the line we speak of as the typical Y-formation. This is formed by the lateral wall of the nose coming forward. And, as the internal wall of the maxillary sinus comes forward, we find that the anterior wall of the maxillary sinus curves outward and backward and the nasal fossa continues on forward. Here we have a mass of cancellated bone supporting the canine and premolar teeth. In a roentgenogram of this type, we will pick up the Y-formation which you saw in some of the slides shown and this is a very important diagnostic point in interpreting these films. If the "Y" is lost, we know there is some destruction. We find this "Y" and point out anatomical landmarks, and then look for pathological lesions.

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THE DIFFERENTIAL DIAGNOSIS BETWEEN INFECTION AND MALIGNANCY IN CASES OF DORSAL PARAVERTEBRAL MASS*

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DURING recent years three cases of malignancy of the spine have come under our observation which showed a paravertebral mass in addition to the bony changes in the spine proper. Tuberculosis is almost invariably considered when destructive changes are evident in the spine in association with a paravertebral mass. The diagnosis and prognosis made under these circumstances are usually correct because of the great prevalence of Pott's disease of the spine. However, other conditions have been recognized as capable of producing these changes, such as subacute or chronic osteomyelitis of the spine or very rarely an infection due to one of the fungi. Relatively little is observed in the literature concerning the possibility of etiological agencies other than infection.† We have analyzed our three cases from the roentgenological standpoint and the present paper will deal with possible differentiating features between malignancy and infection.

CASE REPORTS

CASE 1. The patient was a white girl, aged fourteen, who was admitted to the hospital on a stretcher with paralysis of both legs. The patient had been well until two years prior to admission when she became ill with scarlet fever, followed by a very slow recovery, with aches and pains in the hip and shoulder joints. The pain was sufficient to cause limping while walking and the usual medication by mouth was relatively ineffective. She never fully recovered from this pain but it was alleviated by electric pads until about six months before admission when her symptoms became aggravated and she noted some numbness in her feet. Her limp grew progressively worse and within a few weeks she was unable to walk. At approximately the same time she became incontinent of urine and feces. A hot water bag applied by a local physician had resulted in rather severe burns without the patient experiencing any pain. Her incontinence of urine and stools continued, together with the paralysis of both legs with varying intensity. Roentgenograms of her spine taken in another city were reported negative.

On physical examination the chief signs were of a neurological character. There was a complete spastic paralysis of both lower extremities with muscular atrophy presenting an upper sensory level at the 4th dorsal vertebra. Below this level hypesthesia to pin prick and to cotton wool and an absence of temperature sense were noted. The abdominal reflexes were absent. The tendon reflexes of the lower extremities were greatly increased. There were also positive Babinski, Oppenheim and Gordon responses. The laboratory findings were without interest.

From the physical examination it was concluded that the patient suffered from a transverse myelitis of the spinal cord at the upper dorsal level with an almost complete motor and sensory paralysis. An infectious myelitis was considered as a possibility prior to the taking of the roentgenograms.

Roentgen Examination. Stereoscopic anteroposterior and single lateral films of dorsal spine (Fig. 1). The films showed a definite destructive process involving the 2nd and 3rd dorsal bodies, particularly the latter. The bone remaining about the areas of destruction appeared diffusely increased in density. The sides or lateral aspects of the bodies showed relatively large areas of destruction, while the articular plates were quite well preserved. The disc space between the 2nd and 3rd dorsal bodies was slightly but definitely narrowed. Along either side of the spine was a large spindle-shaped shadow suggesting a large paravertebral abscess. This mass extended along the spine down

† Since writing this paper, the article by Jansson[21] on xanthomatosis has appeared.

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Fig. 1. Case I. Fibrosarcoma of the spine involving the 3rd and 4th thoracic vertebrae with large heart-shaped paravertebral mass. Note areas of destruction along the sides of the 3rd dorsal body with good preservation of the articular plates. Other signs indicative of malignancy are diffuse increase in bone density of the body and the relatively slight narrowing of the disc spaces.

to the level of the 6th dorsal. While slight compression of the 3rd dorsal body had occurred, there was no appreciable degree of kyphos. At the time the examination was made it was believed that the destructive changes within the upper dorsal vertebrae were probably due to an infection and that the paravertebral mass represented an abscess.

A subarachnoid block was demonstrated on lumbar puncture. An orthopedic consultant thought that the process was tuberculosis and advised a Hibbs fusion. At operation malignant tissue was encountered. The laminae and posterior spinous processes were removed from the 3rd, 4th and 5th lumbar vertebrae. Tumor tissue was found overlying the cord, but because of its character no attempt was made at removal. The biopsy report from the portions of bone removed at operation revealed a rather cellular tumor with the cells rather closely applied to the connective tissue. Mytotic figures were few. It had the cytological appearance of sarcoma rather than endothelioma. The patient received small amounts of roentgen radiation and some radium therapy. Subsequent roentgenograms of the spine showed no diminution in the size of the paravertebral mass and it was believed that at least one of the bodies had undergone further destruction and collapse. She did not improve appreciably and was discharged. She was seen once following discharge when all symptoms had become greatly aggravated. It was evident on examination that there was little to be done for her except to control pain and to provide nursing

Fig. 2. Case II. Fibrosarcoma of the spine with narrow spindle-shaped paravertebral mass. The left border of the mass lies close to the spine within the shadow of the descending aorta. The 8th dorsal body has collapsed to half its normal height. The articular plates and the discs have been remarkably well preserved for the extent of the collapse.

care, exitus being imminent. Biopsy diagnosis: Fibrosarcoma.

Case II. The patient, a male, aged forty-three, entered the hospital complaining of pain in the abdomen and lower chest of three months' duration. The pain was rather unusual in that the patient described it as starting over the epigastrium and travelling along the sides of the chest and upward over the back to the region of the scapulae. The pain was usually aggravated by deep breathing, coughing and posture. The patient was extremely depressed and had lost about 10 pounds in weight during the month prior to admission. Physical examination revealed little of note. The neurological examination was negative except for nystagmus on lateral deviation of the eyes, some increase in tendon reflexes and a questionable Babinski reaction on the right. Spasm was also apparent involving the paravertebral muscles on the left side of the spine. Sensory changes were absent. No block was demonstrated on lumbar puncture.

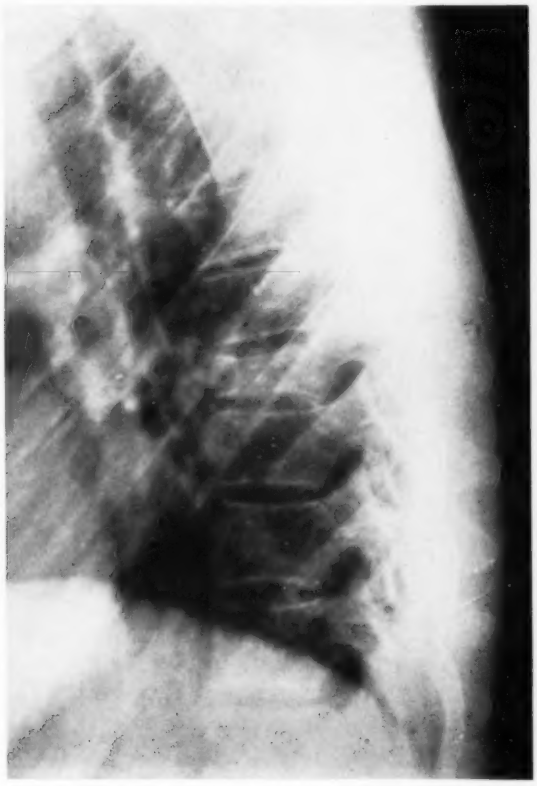

Fig. 3. Case II. Fibrosarcoma of the spine. Note the rather uniform collapse of the body with little alteration in width of the adjacent disc spaces.

Fig. 4. Case II. Roentgenogram of specimen obtained at autopsy. The hemisection of the spine has resulted in an extensive comminution of the fragile bone of the collapsed body. Note increased density of the invaded bone and extension anteriorly of the paravertebral mass.

Roentgen Examination. Stereoscopic anteroposterior and single lateral films of dorsolumbar spine (Figs. 2, 3 and 4). The 8th dorsal body showed marked collapse, its height being approximately half normal. The disc space between the 8th and 9th dorsal bodies was fairly well preserved. Slight narrowing was apparent at the disc space between the 7th and 8th. The lateral film, however, showed a rather extensive collapse of the 8th dorsal body with slight changes at the disc cartilage. A paravertebral mass of fusiform shape was present running along the dorsal spine at the level of the 5th to the 10th dorsal. The lesion appeared essentially destructive in character though stereoscopic films showed some increased density of a finely granular character. A chest film

Fig. 5. Case III. Metastatic melanosarcoma with paravertebral mass. The preservation of the disc cartilage and the articular plates are striking features of the examination.

showed a pneumonic area in the lower right lung. A gastrointestinal series gave no information of importance.

A Hibbs fusion operation was carried out. Shortly after discharge the patient returned to the hospital complaining of increase in numbness and difficulty in moving the lower extremities. The disturbance in sensation corresponded with the level of the 8th and 9th dorsal vertebrae. It was then believed that he was suffering from paralysis as a result of a paravertebral abscess. The patient experienced difficulty in evacuating the contents of the bladder and the bowel. A lumbar puncture carried out at this time showed evidence of a subarachnoid block. Films of the spine did not show the progressive changes usually seen in the disc cartilages in cases of tuberculosis. The bodies appeared somewhat increased in density, suggesting that further collapse had occurred. The large paravertebral mass was decidedly asymmetrical and had increased considerably in size. Note was made of the fact that there were two unusual features in this case as regards the diagnosis of tuberculosis: first, there was a remarkable preservation of disc cartilage over a considerable period of time during which the destructive changes in the body had increased and secondly, the soft tissue masses had an unusual configuration on either side of the spine. The patient was reoperated primarily to clear up the diagnosis. Anterior to the transverse process of the 5th dorsal a mass was encountered and biopsy material obtained. Microscopic examination showed cells of the spindle or oat-cell type with hyperchromatic vesicular nuclei. Occasional mitotic figures were encountered. After operation the patient did poorly, showing clinical evidence of a bronchopneumonia. He died approximately two weeks after the second operation.

Anatomical Diagnosis. Paravertebral fibrosarcoma of midthoracic region with metastases to pleura, pericardium and mediastinal lymph nodes; dissemination through vertebral column with compression of spinal cord; confluent bronchopneumonia, left; fibrinous pleurisy, left; pyelitis, membranous cystitis, benign prostatic hypertrophy; acute prostatitis; mild generalized arteriosclerosis; decubitus ulcers.

Case III. The patient was an adult, white female, aged thirty-six, who entered the hospital complaining of paralysis and numbness of legs and lower portion of body. The patient apparently had been well until six weeks prior to admittance. At this time she developed much severe pain near the angle of the left scapula. This pain later spread toward the front of the body involving a strip about 6 cm. wide which included the lower half of the breast. The pain was almost unbearable and prevented sleep. Four days prior to admittance she had gone to a masseur who had treated her feet. On the morning following the treatment she noted that both feet were numb and weak, the right more so than the left. During the course of that day the numbness and paralysis extended up her side preventing walking. She had been constipated during her illness and had not had an evacuation during the twelve hours before admission. Her physical examination was essentially negative except for the neurological portion. There was a flaccid paral-

ysis of the lower extremities with lack of proprioceptive, thermal and pain sensation over both lower extremities. The knee and ankle jerks and abdominal reflexes could not be elicited. There was local tenderness on palpation over the 5th, 6th and 7th dorsal vertebrae. A lumbar puncture showed evidence of spinal block

Roentgen Examination. Stereoscopic anteroposterior and single lateral films of dorsal spine (Figs. 5, 6 and 7). The 4th dorsal body was found collapsed to one-half its normal height with relatively little disturbance in the width of the joint space between the 4th and 5th dorsal. There was no evidence of new bone formation. A paravertebral mass was observed on both sides of the spine at the level of the 4th, 5th and 6th dorsal vertebrae. Due to the fact that there was no wedging such as one usually notes in cases of collapse in tuberculosis and substantially little or no change in the width of the adjacent disc spaces, it was felt that this was not similar to the usual case of Pott's disease. While it was thought that it might represent an unusual variant of it, the more likely diagnosis was believed to be malignancy. Recalling our previous experiences with malignancy of the spine the following note was included in the interpretation: "There is undoubtedly a paravertebral mass. On rare occasions such a mass is found to be due to solid tumor rather than the usual paravertebral abscess of tuberculosis. The possibility therefore of primary malignancy should be borne in mind, for this process would explain all the shadows seen on the present roentgenograms."

Fig. 6. Case III. Metastatic melanosarcoma with paravertebral mass. Note the uniform type of collapse of the bodies.

Fig. 7. Case III. Lateral roentgenogram of specimen obtained at autopsy (after hemisection).

In view of the hopeless prognosis no therapy was tried, though before discharge from the hospital a chest film was obtained which showed shadows consistent with secondary malignancy of the lung. This process was very diffuse involving both lung fields. The patient died apparently from paralysis of the muscles of respiration. A check on the patient's history after the autopsy revealed that a pigmented mole had been removed from the skin of the anterior abdominal wall one year before admission to the hospital.

Anatomical Diagnosis. Melanosarcoma with involvement of the 4th and 5th dorsal vertebrae resulting in cord compression; sarcomatosis of lungs; metastases to liver, left kidney, hilar, retroperitoneal and mesenteric lymph glands; pulmonary congestion and edema; acute splenic tumor; congenital deformity of frontal cortex; adenomatous thyroid.

These 3 cases are similar in showing a fulminating course with a progressive paralysis suggesting cord compression. In all 3 cases at some time during the clinical course spinal block was established on lumbar puncture. Roentgenologically there were further similarities in that they showed involvement of one or more of the dorsal vertebral bodies with collapse (varying from very slight to marked) and clear-cut evidence of a paravertebral mass. In all 3 cases a histological study of the tissue removed either at the time of biopsy or of autopsy revealed that the changes were due to malignancy.

Additional clinical similarities are to be noted in the absence of any kyphotic deformity and in the absence of any presenting lump or mass to suggest the penetration peripherally of an abscess, such as one notes in many cases of tuberculosis. The pain in these cases was usually very severe preventing sleep, and often caused the patient to pace the floor up to the period when a supervening paralysis prevented such activity. All 3 cases showed local tenderness on pressure or percussion over the affected level of the spine. Two of the 3 cases were practically afebrile but the third showed a slight fever of several degrees throughout the stay in the hospital.

A comparison of the roentgenological features is of particular interest.

Type of Collapse. In each of these 3 cases the wedging usually observed in tuberculosis was absent, the collapse of the body occurring more or less uniformly throughout the body to produce an "accordion" effect. The degree of collapse varied from a very slight amount to approximately one-half of the height of the vertebral bodies. Ten cases of tuberculosis of the spine verified either by inoculation or staining for acid-fast bacilli were selected from our records for purposes of comparison with the malignant changes and it was found that wedging was quite definite in all except two. In one of these no collapse at all was apparent and in the other there was a very slight settling of the body in general.

Kyphos. In only one of the 2 cases of malignancy of the spine was any kyphotic deformity evident and in this case the degree of kyphos was very slight, particularly in relation to the amount of collapse which had occurred. The absence of kyphos of course is readily explained on the basis of the rather uniform collapse of the bodies. In the series of cases of tuberculosis of the spine kyphotic deformities varying from slight to marked were apparent in 7 of the 10 cases.

Mottling. The 2 cases of fibrosarcoma both showed evidence of mottling. In one the mottling was fairly coarse while the other was of a fine granular character. In only 2 of the 10 cases of tuberculosis of the spine was any mottling made out in any of the vertebral bodies.

Changes in the Disc Space. All 3 malignant cases showed either an absence or a very slight degree of narrowing of the disc space for the amount of involvement of the vertebral bodies. This is quite in contrast with cases of tuberculosis in which the narrowing was usually of a marked character. In one case the disc space was practically absent.

Changes in Density. In the 2 cases of fibrosarcoma the ones showing mottling also showed some localized increased bone density to account for this mottling, while in the case of metastatic melanosarcoma there was no change in the density of the body and no mottling. In tuberculosis local areas of increased density may be observed occasionally in the vertebral bodies due to repair of bone. It is rare however that this repair goes on diffusely throughout the body. It is usually of a localized character located about the region of the wedging, while in cases of malignancy the body in general has a changed appearance in those cases where mottling is present.

Outline of Articular Plates. One of the most remarkable findings in reviewing the films of our cases of malignancy was the

preservation of the articular plates of the bodies in the presence of collapse. This preservation of the articular plates is observed on the anteroposterior films but it is seen to best advantage on suitable lateral films where sharp margins superiorly and inferiorly are made out at collapsed bodies. This appearance is quite unlike that usually seen in tuberculosis where the destruction in a body occurs adjacent to one of the articular plates. These plates become indistinct, showing bone absorption by decalcification and caries.

Changes in Appendages of the Vertebrae. The 3 cases of malignancy showed either involvement of one or more spinous processes, pedicles or laminae. Two of the 3 cases showed typical changes within the vertebral ends of one of the ribs. This type of involvement is distinctly unusual in cases of tuberculosis. It is true however that the pedicles may appear indistinct on the anteroposterior film in cases of tuberculosis. This is largely due to the erosion of the bodies close to the pedicles rather than to an extension of the process into the vertebral arch. In one case of tuberculosis, however, there was involvement of the 12th thoracic rib. An extensive involvement of the posterior portion of the vertebra, however, would speak very strongly for malignancy or if due to infection would usually be due to osteomyelitis rather than to tuberculosis.

Paravertebral Mass. In malignant cases the shape of the mass varied considerably from a heart-shaped mass to one of the fusiform type. One of the three showed a definite tendency toward lobulation of the border. In tuberculosis most of the masses were of the fusiform type but one presented a heart shape and another showed a definite tendency toward lobulation. The position of the mass in relation to the level of collapsed vertebrae did not appear to be significant in separating these two groups. In the case of malignancy the mass extended both above and below the vertebrae which were obviously affected. The same is true of tuberculosis. In one of the fibrosarcomas the paravertebral mass extended along five of the dorsal vertebrae, while in one of the tuberculosis cases, the mass extended along as many as seven vertebrae. The level of maximum salience in both the cases of infection and malignancy was found to correspond roughly with the bodies which were most affected. In both cases the paravertebral mass extended down below the level of apparent involvement of bone. An unexplainable feature of these masses in both the malignant and infectious cases relates to the more extensive involvement along the left side of the spine rather than the right. Not infrequently the mass appeared wider on the left side, but of greater interest was the fact that in nearly every case the mass extended for a longer distance along the left side of the spine without any apparent anatomical explanation for such an effect. None of the cases of malignancy showed any evidence of calcification within the paravertebral mass, while several of the cases of tuberculosis showed definite calcification. Roentgenograms of the chest were obtained in all 3 cases of malignancy and in most of the cases of tuberculosis. There were negative results as regards a tuberculous infection in the cases of malignancy while in those of tuberculosis one showed a definite process of a recent character and 2 showed evidence of old infection. The remaining cases were essentially normal except for one in which no examination was made.

In summarizing the features of these series, it is apparent that the shape, size and location of the paravertebral mass appears to have no real significance in differentiating malignancy from infection. In the event that definite calcium deposit can be identified within the mass this of course gives a very valuable clue as regards the etiology, though it must be stated that such calcification is not commonly observed. The more important differential features relate either to the body or the disc space. In cases of paravertebral mass,

particular attention should be directed to the changes occurring within these two portions of the vertebral spine. In a case of paravertebral mass in which a uniform collapse of the body with clear-cut preservation of the articular plates is noted, the evidence is very much in favor of malignancy. Similarly if there is little or no narrowing of the joint space between the affected bodies, or such changes as may be present are insignificant in relation to the marked degree of involvement of the vertebral bodies, this likewise speaks in favor of malignancy rather than an infectious process. A third differential characteristic is the frequent involvement of the appendages of the vertebrae in addition to the bodies in cases of malignancy. There are less important changes which may be of value in some cases. If the body appears definitely increased in density and one can distinguish this change in density from that which occurs in infection due to repair, this finding favors a malignant origin. Tuberculosis may affect multiple levels of the spine while the cases of malignancy that have come under our observation have been restricted to one level. The negative findings of the chest examination are of no value, though in one of the cases of malignancy there was positive evidence of metastatic process of the lung and in several cases of tuberculosis the typical changes of this disease were noted.

DIFFERENTIAL DIAGNOSIS

In cases of tuberculosis multiple areas may be affected. The type of collapse typically is one of wedging rather than a uniform collapse. Any increase in density within the body is due to attempts at repair of the areas of destruction. The articular plates are usually indistinct and may be entirely absorbed. Kyphos is characteristic and is dependent upon the degree of wedging. The appendages of the vertebrae are not affected. The paravertebral mass may vary greatly in shape and size and is not characteristic unless calcium deposits can be definitely identified. In some cases the outlining of a paravertebral mass may be the first roentgenological change (Doub and Badgley).[10] The disc cartilage is narrowed usually quite early in the course of infection and in the latter stages of disease may be practically entirely destroyed. Roentgenographic signs should be correlated with the clinical examination. It should be recalled that fever is commonly absent. A local swelling indicating the pointing of an abscess may be identified in some cases. Often no acute local tenderness can be made out in spite of the fact that the degree of collapse may be very pronounced. The most definite of all of these clinical features as regards differential diagnosis is the pointing of a fluid mass. The degree of pain is frequently insignificant for the extensive character of the lesion, while in malignancy the pain is more characteristically excruciating, often preventing sleep.

Osteomyelitis is more difficult to differentiate. This disease is distinctly more rare than tuberculosis and when present usually does not involve the dorsal spine. In this type of infection the organism shows a predilection for the regions of the arches and processes rather than the bodies. In those cases in which the bodies are involved there are usually one or more of the appendages affected. It usually involves the disc space and therefore may simulate tuberculosis in this respect. There is, however, a tendency toward sequestration and, as the process progresses, reparative bone is laid down to considerably increase the density of local areas of the part infected. Gibbus may occur in those cases in which the body is affected. Local abscesses develop in much the same way as in cases of tuberculosis with the formation of psoas abscess, mediastinal abscess, lumbar abscess or retropharyngeal abscess. Sussman[29] has described 4 cases of chronic osteomyelitis, 3 of which were at the lumbar and one at the cervical level. Symmetrical paravertebral masses were noted in two. Localized new bone formation with spur formation, uniform narrowing of

joint spaces, destruction of the vertebral appendages and finally complete destruction of the vertebrae and discs were other evidences of infection. Klein[22] has expressed the opinion that in the acute form of osteomyelitis, no changes may be noted. This would appear to be in line with our common experience in dealing with acute suppurative lesions of the long bones. The first change observed by Klein was joint-space narrowing which usually required two or more weeks for its recognition. Esau[11], however, describes a paravertebral shadow in relation to acute osteomyelitis which helped materially in the early roentgenological diagnosis. It would appear reasonable to assume that either joint-space narrowing or paravertebral abscess may be the first sign in cases of osteomyelitis in much the same manner as in cases of tuberculosis. Neither of these signs can be expected with any regularity during the first few weeks of the infection. The clinical history may give some clue as to the type of infection since these cases not infrequently show a rather acute onset with a severe systemic reaction. Temperatures are commonly higher than those observed in cases of tuberculosis or malignancy. On occasion blood cultures or cultures obtained from uncontaminated urine specimens may reveal the presence of the causal organism.

When fungus infections invade bone, the site varies somewhat with the causal organism. Blastomycosis attacks both the long and flat bones, including the spine. Stober[28] reports involvement of the long bones the more common, the lesion beginning in the spongy portion of the epiphysis. A noteworthy characteristic is the sharp demarcation between normal and diseased bone. Raiford[26] mentions the multiple shotty dissolution of bone, the small bones of the hands and feet being most often involved, followed by spine and lower tibiae. The skin is the last to show the infection. Simpson and McIntosh[27] reviewed 28 cases of actinomycosis and added 4 cases of their own which were originally diagnosed as tuberculosis. This type of infection most often involves only one bone and is apt to progress by simple massive extension. The infection is chronic and often associated with primary involvement of the gastrointestinal tract and complicated by lung lesions. Coccidioidal granuloma is a rare disease in the eastern portion of the United States and is described by Carter[7] as producing multiple lesions usually sparing tubular bone. New bone formation is more conspicuous than tuberculosis, as a rule. The course is more rapid with no tendency to spontaneous healing.

Primary tumors of bone or cartilage rarely arise in the spine. Geschickter and Copeland, in reviewing 271 cases (including cases of primary chondromyosarcoma, osteogenic sarcoma and chondroblastic sarcoma), found only 3 cases originating within the spine (2 lumbar and 1 sacral). Camp, Adson and Shugrue,[6] in discussing the roentgenographic findings associated with tumors of the spinal cord and the associated tissues, comment that malignancy of the spine may present an appearance identical with tuberculosis. Ewing's tumor while seldom arising within the spine may metastasize to it (Geschickter and Copeland).[14] These latter writers make no mention of paravertebral masses being discovered by the roentgen ray, though this tumor is known to produce bulky, soft tissue tumors. It is quite possible, therefore, that this form of tumor may produce paravertebral shadows on the roentgenogram similar in appearance to those now under discussion. Such case reports have not come to our attention.

Occasionally tumors such as hemangioma, multiple myeloma, chordoma and Hodgkin's disease may involve the spine and produce the clinical effects of a paraplegia. Nattrass and Ramage[24] report an unverified case of hemangioma involving the 8th dorsal vertebra. The body of this vertebra showed the typical vertical striations. The pedicles were broadened and presented a mottled appearance. The intervertebral discs were intact. These writers

TABLE OF DIFFERENTIAL FEATURES

	Tuberculosis	Osteomyelitis	Mycotic Infections	Primary Malignant Tumors of bone	Metastatic Malignancy	Fibrosarcoma	Lymphoblastoma	Chordoma	Hemangioma	Multiple Myeloma
Frequency in spine	Most common	Occasional	Least common of infections	Very rare in spine	Frequent	Uncommon	Uncommon	Rare, practically never at dorsal level	Common	Frequent
Other bones affected	Hip, knee joints	Long bones particularly	Flat bones particularly, except for blastomyces infection	Long bones at knee and shoulder	Pelvis, skull, ribs, long bones	Long bones	Pelvis, sternum, skull, long bones,	Absent except within cranium at basilar plate	Flat and long bones	Sternum, clavicle, ribs, pelvis, skull, long bones
Single or multiple levels in spine	May be multiple	Usually single	Usually single	Single	Often multiple	Single	Often multiple	Single	Often multiple	Often multiple
Portion of spine	Dorsal most common	Uncommon in dorsal	Wide distribution	Uncommon in dorsal	Any level	May occur in dorsal	Dorsal or lumbar	Very rare in dorsal	Most often in dorsal	Most often in lower dorsal and lumbar
Joint space narrowing	One of the earliest signs. May be the first	May be an early sign	Often occurs late	Usually does not extend beyond joint	Joint spaces usually unaffected	Usually affected little or none	Usually unaffected	Discs frequently narrowed and may disappear	Usually undisturbed	Usually undisturbed
Body	Ill-defined areas of destruction with collapse	Ill-defined areas of destruction with early reparative bone lipping, etc.	Often sharply defined and circumscribed		Either bone destruction with collapse or increased bone density	Commonly a granular appearance	Usually purely destructive; may be osteoblastic	Often invades bone with diffuse increase in bone density	Vertical coarse striations with areas of absorption between	Purely destructive
Appendages	Uninvolved	Commonly involved	Commonly involved		Uncommon	Commonly involved	May locally erode laminae	Body chiefly affected but may extend into laminae	May extend into appendages	May extend into appendages
Paravertebral mass	Common, may be first sign	Common, may be first sign	Has been described in cases of actinomycosis	Rare	Rare	Common	Unknown	Unknown	Rare	Rare
Type of collapse	Wedging typical	Mushrooming with hypertrophic lipping	May cause wedging		Variable	Accordion effect	Degree of collapse slight for extent of involvement	May collapse	Rarely collapse	Gradual settling of bodies; in one case complete disappearance
Osteolytic or osteoblastic	Osteolytic except for late repair	Osteolytic combined with early lipping	Mainly osteolytic with surrounding normal bone		Either; osteolytic more common	Diffuse osteoblastic reaction	Purely osteolytic, osteoblastic or mixed	Erodes and invades bone to produce osteoblastic effect	Areas of absorbed bone between coarse irregular vertical striations	Purely osteolytic
Articular plates	Destroyed early	Irregular, indistinct	Variable		Usually well preserved	Usually well preserved	Well preserved or local defects	Variable	Usually well preserved	Multiple infractions

mention a soft tissue shadow on both sides of the spine which they were unable to explain. If this case is one of true hemangioma, the roentgenological findings are somewhat unusual in that this tumor usually does not extend beyond the periosteum and one should not expect a paravertebral mass. The cases coming under our observation fail to show any recognizable degree of collapse. The articular plates are usually intact. The vertical striations with areas of atrophy between the striae give a very definitive picture for this form of tumor (Alpers and Pancoast;[2] Bailey and Bucy;[4] Bucy and Capp[5]). Most of these tumors are silent during the life of the individual and are discovered at the autopsy table. Since the pedicles are often involved by this process, it is possible for this form of tumor to produce the signs of cord compression due to intraspinal extension but the latter is not usually associated with any collapse of the body.

Multiple myeloma with its frequent localization in bone may offer some opportunity for confusion since the masses often extend beyond the confines of the bone and involve the adjacent soft tissue structures (Meyerding).[23] As its name implies, the lesion is commonly multiple and if skull and rib films are obtained the diagnosis may become evident. Jacox and Kahn[20] report a case of multiple myeloma with spinal cord involvement. The lesion was purely destructive. The intervertebral discs were well preserved. This case was quite unusual in that the body of the vertebra entirely disappeared. In spite of the extensive destruction no paravertebral mass was present, though at operation tumor was observed around the nerve roots. Some of the forms of Hodgkin's disease show a localization in bone and in such cases the spine may be one of the regions involved. One of the cases reported by Ginsburg[15] showed evidence of an erosion of one of the laminae at operation. Dickson and Hill[9] report a most unusual case of metastatic carcinoma of the prostate which localized in the vertebral column and simulated Pott's disease clinically, with collapse of the seventh cervical and first dorsal. The cord compression was demonstrated in this case to be due to the backward thrust of the disc cartilages as a result of the vertebral collapse. Other cases have been described in metastatic malignancy where intraspinal extension of malignant tissue accounted for the clinical signs of transverse myelitis. It should be observed that in these cases of diverse etiology the roentgenological demonstration of a paravertebral mass is usually absent.

Chordomas are rarely observed at the dorsal level, most of the tumors occurring at the two ends of the spine (sacrum or upper cervical spine) and within the cranium at the basilar plate. Hutton and Young[19] report an unusual case in the involvement of the fifth and sixth dorsals. The discs between these two bodies were destroyed, forming an ill-defined mass. The tumor at operation was found entirely within the thecal sac, though extension into the lamina had occurred. Davison and Weil[8] and Zollinger[32] described cases involving the lumbar level. Sclerosis of portions of the bodies and narrowing of joint spaces characterize the first case while the appearance of the lumbar body in the second case simulated a compression fracture with local increase in density in the affected portions of the body. A relatively large series of chordomas (13 cases) have been recently described by Adson, Kernohan and Woltman[1] and Fletcher, Woltman and Adson[12] of the Mayo Clinic. In none of these cases was there any involvement of the dorsal spine.

In summary, it may be safely said that infection is the most frequent cause for the discovery of a paravertebral mass, with tuberculosis heading the list of infections and osteomyelitis and fungus infections following in order. Malignant tumors arising from bone or cartilage are distinctly uncommon in the spine but fibrosarcomata arising from the contiguous structures of the spine should receive consideration in atypi-

cal cases. Rarely metastatic malignancy and under most exceptional circumstances benign tumors such as hemangioma have been reported in association with paravertebral masses.

CONCLUSIONS

Two cases of primary and one of metastatic malignancy of the spine producing paravertebral masses have been described.

The differentiating features in cases of paravertebral mass have been discussed in reference to tuberculosis and other infections of the spine as well as to benign and malignant tumors.

The more important of these features are (*a*) preservation of the articular plates in the presence of collapse of the body, (*b*) slight or no narrowing of disc spaces in cases of marked collapse, (*c*) the absence of wedging resulting in little or no kyphos, (*d*) diffuse increase in bone density, and (*e*) involvement of the appendages of the vertebra.

No single one of these criteria is sufficient to establish the roentgenological diagnosis of malignancy. A thorough analysis of all these criteria secured in conjunction with the clinical history is usually required.

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CONGENITAL CYSTIC DISEASE OF THE LUNGS*

A CLINICOPATHOLOGICAL STUDY

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THE nomenclature for congenital cystic disease of the lungs is quite varied and sometimes confusing. The condition has been designated by such terms as atelectatic bronchiectasis, congenital bronchiectasis, telangiectatica, bronchiolectasis, fetal bronchiectasis, congenital cystic malformation of the lung, honeycombed lung, cystic fetal bronchial adenoma, congenital pulmonary lymphangiectasis, etc., depending on what was considered by the writer to be the pathogenesis of the lesion. To avoid confusion, and irrespective of the underlying genesis, inasmuch as different observers considered their respective case to represent certain basic features, it would be best to regard the condition under the heading of "congenital cystic disease of the lungs." This broad designation satisfactorily includes the many bizarre types that are often met with, and firmly establishes an entity that is more frequently being recognized not only on the post-mortem table, but also during life.

HISTORICAL

Although this disease is considered rare, nevertheless 232 cases have appeared thus far in the world's literature. As early as 1687, Bartholinus[6] described a case in a female child of four years with a sac of air replacing the upper lobe of the left lung. Meyer's[63] description of a case in 1859 really made the condition known. He reported a cyst, the size of a hazel-nut, which communicated with a bronchus, situated at the right hilus of the lung and many smaller cysts scattered over the surface of both lungs in a six months fetus. He accredited the first reported case to Nicholaus Fantanus,[30] who described a large bladder of air which communicated with the bronchi in the lung of a markedly cyanotic infant of three months.

In 1925, Koontz[49] collected 108 cases of congenital cystic disease of the lungs. Since then, there has been a rapid succession of recorded cases, so that at the present writing I have been able to collect 124 additional cases recorded all over the world. This apparent increase in the number of patients with pulmonary cystic disease has been attributed to the interest created by Koontz's paper and by the more refined methods employed in the last decade to recognize the condition during life, such as the more frequent use of the bronchoscope and roentgenoscope. The 108 cases compiled by Koontz appeared only in foreign literature. Of the 124 cases since collected by me, over half have emanated from the United States.

INCIDENCE

Although there are no statistics regarding the incidence of pulmonary cystic disease of congenital origin, nevertheless the available facts indicate that this condition is rare. Lenk[54] recognized 6 cases in 10,000 roentgen examinations of the chest. Lederer[52] has failed to find one in over 5,000 necropsies, which included many infants. Granting that a number of cases may have escaped diagnosis, yet the lesion is apparently very rare and, unless one is on the lookout, it may be easily overlooked or missed. In a recent publication (1934), Sauerbruch[85] believed that fully 80 per cent of bronchiectases of childhood limited to one lobe are of congenital origin. As proof of this contention he pointed out that there were no pleural adhesions or inflammatory pulmonary alterations in the 58 lobes resected by him, the lesions consisting of widening of the bronchi and thickening of the pulmonary tissue. Additional proof is furnished by the histories of these cases. They did not exhibit a tendency to

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colds, nor did the bronchiectasis develop as an immediate sequel to influenzal or whooping cough pneumonia. It is likewise noteworthy that the lung is frequently the seat of congenital malformations, such as cysts of the bronchi or of the pulmonary tissue. Hence, Sauerbruch concluded that congenital bronchiectasis, though little appreciated by pediatricians, is not an infrequent clinical entity.

An analysis of the 232 available cases shows that the male sex slightly predominates (107 males, 88 females). The age at which symptoms are first noted varies considerably, notwithstanding the fact that the condition is now generally accepted as congenital (Table 1). The onset of the symptoms may be at birth or soon thereafter. Not infrequently, the lesion is the cause of a stillbirth.

Table I

AGE AT WHICH CONDITION WAS RECOGNIZED

	Number of Patients
At birth	27
Under 1 yr.	41
Between 1 and 15 yr.	38
Over 15 yr.	118
Total	224

Although it is the exception rather than the rule, the patient may have no symptoms referable to the chest and may die of some other malady after a long life. Buchmann[15] reported such a case in an eighty-four year old woman who died of apoplexy. At necropsy, many cystic cavities which communicated with the bronchi and contained mucopus were found accidentally. Detailed examination of the cystic wall showed the presence of strongly developed muscle tissue, elastic tissue and cartilage, findings which indicated their bronchial origin. The absence of pigmentation or anthracotic deposits demonstrated the congenital origin of the lesion. Similar accidental findings on post-mortem examination were reported by Lotmar,[60] Gold,[35] Eloesser,[29] Vadone,[95] Rosenthal,[81] and Poiré and Chabaneix.[78] Wood[101] encountered a year old female infant with a tuberculous right otitis media and with no symptoms or signs referable to the chest. The finding of a solitary fluid cyst on the roentgenograms was an accidental discovery. A large air cavity at the base of the right lung, interpreted by Gutiérrez[37] as a congenital cyst, was an unexpected roentgen finding in a male adult who presented no signs or symptoms of the lesion.

ETIOLOGY AND PATHOLOGY

Pearson[76] described cystic disease as a condition that includes abnormal localized distention of the various portions of the tracheobronchial tree and other discrete sacs originating from the interstitial portion of the lung. Although the lesion is considered by most writers to be congenital in origin, nevertheless this opinion is not unanimous. The various theories of the pathogenesis of congenital cystic disease of the lung may be classified roughly into the following six groups:

1. Pulmonary cystic disease represents a tumor growth. This view was strongly held by Stoerk[91] (1897), who applied the term "cystic fetal bronchial adenoma." The presence of excessive tubular outgrowth which arises from the bronchial dilatations and projects into the connective tissue stroma provoked Stoerk's suggestion that the condition is adenomatous. Cyst adenomatous changes were also described by Heller,[39] Löhlein,[59] Buchmann,[15] Linser,[57,58] Muus,[67] Björkstén,[10] Hückel,[42] and Altmann.[2] Attributing the formation of the dilated spaces and the increased size of the affected lung or lobe to neoplasm is considered unreasonable by Pappenheimer,[74] Miller,[64] and others, inasmuch as the findings are by no means constant and the theory adds nothing to the causation of tumor growth.

2. Syphilis is the underlying cause in the production of cystic pulmonary disease. Sandoz[83] observed the presence of bilateral pulmonary polycystic cavities in twin sisters with a congenital luetic infection.

He believed that the faulty development of alveoli from the small end-bulbs of the bronchial tree in the embryo was due to the congenital syphilis. Balzer and Grandhomme's[5] patient, a new-born infant, was also a syphilitic. Oudendal[73] considered the cystic anomaly to be caused by fetal pleural adhesions probably produced by a luetic infection. However, most patients show the absence of syphilis, and its presence may be merely coincidental.

3. Cystic disease of the lung is a sequel to a pneumonic process. This view was supported by Box,[12] Bernstein,[8] Kanthack and Rolleston,[44] and other British writers, who were of the opinion that a bronchopneumonia is the underlying factor. The fallacy of this theory is evident by the numerous cases which show no evidence of an inflammatory process. Not infrequently, however, an inflammatory condition is superimposed upon the congenital lung defect. Eloesser[28] reported a case in a student, twenty years old, who was observed for ten years with a chronic empyema following a pneumonic infection. On exploration, a multilocular cyst of the left lower lobe was found containing pus and communicating with a bronchus. Histological study of the removed specimen demonstrated its congenital origin. Miller,[64] Wood,[101] and others, believed that the cavities in their patients are the result of an anomalous development rather than a sequel to an acquired disease such as bronchopneumonia. Although the cysts frequently become secondarily infected, either through their communicating bronchus or from a surrounding pneumonic lesion to which these patients are susceptible, it does not necessarily follow that the cysts develop from this infection. However, the pneumonia or superimposed infection may so completely mask the underlying congenital lesion, as occurred in Eloesser's case, as to render a diagnosis unlikely until the patient is surgically explored or necropsied.

4. Congenital cystic disease of the lung is the result of fetal inflammation producing an inflammatory stenosis or atresia of the bronchi with bronchiectatic dilatation of the distal portions from stagnation of the secretions. Hence, the term "fetal bronchiectasis" was suggested. Stoerk[91] (1897), who favored the adenoma theory, also mentioned fetal inflammatory changes as the second group of abnormalities. The objections to this hypothesis are: (*a*) cysts may communicate with a bronchus, and (*b*) frequently, no gross or microscopic evidence of an inflammatory process is found on necropsy. Pappenheimer's[74] case in a seven months premature infant and Wolman's[100] six months stillborn clearly demonstrate the absence of all evidence of inflammation. Other observers who found no inflammatory changes based on the necropsy findings are Rosenthal,[81] Oechsli and Miles,[71] Mumme,[66] Dumas, Gardère and Jarricot,[26] Ribabeau-Dumas and Rault,[80] Hückel,[42] Wood,[101] Fleming,[31] and Cautley.[18]

5. Dilatations of the lymphatics are considered as the pathogenesis of congenital pulmonary cystic disease. Virchow,[96] Klebs,[46] Grawitz,[36] and others, regarded the mesothelium-lined cysts, scattered through the interstitial pulmonary framework, as lymphangiectatic. Faulty development of the anlagen of the lymph-vessel system of the corresponding lobes of the lung results in these defects of aplasia and hypoplasia. In the seven week old infant reported by Anspach and Wolman,[3] the right middle lobe revealed a congenital lymphangiectatic cystic formation which occupied practically the whole right side of the thorax and communicated with a terminal bronchiole. In Fleming's[31] case of a three year old child, the histological structure of the cyst wall and lining appeared to be of lymphangiectatic rather than of bronchial or atrial origin. It simulated an emphysematous bulla situated near the surface of the middle lobe. Nevertheless, most of the cysts do not have the histological appearance of the lymph system and therefore must be regarded as of different origin. Not infrequently, however, some cysts of bron-

chial origin may closely resemble the morphological appearance of a lymph vessel.

6. A simple arrest of development at a period more or less advanced accounts for the cystic disease. The developmental error may be in the alveoli or in the bronchi. A lack of alveolar development, compensated by a widening of the neighboring bronchi, due to the failure of normal lung expansion at birth was described by Heller[39] as the possible cause. He considered the condition as a congenital atelectasis. Similar views were held by Francke[33] (1894), Orth[72] (1905), Heuter[41] (1914), de Lange[51] (1927), and others. These observers, however, give no reason for the lack of alveolar development. Furthermore, a cystic lesion at the lower portion of a lung is not accounted for by this theory, because the high respiratory variations and volume of the corresponding area of the chest do not permit a prolonged atelectasis (Herms and Mumme[40]). Besides, many atelectatic lungs show no evidence of cyst formation or bronchial dilatations (Lotmar).[60]

That the developmental anomaly is caused by a stenosis of the bronchial branches was the belief expressed by Heuter[41] (1914) and, later, by Swanson, Platou and Sadler[93] (1928). The fact that the cyst walls contain mucous cells, muscle fibers and cartilage indicates their bronchial origin. The secretions in the cyst cause a marked distention which results in distressing symptoms. Miller[64] objected to this hypothesis because a bronchial communication is frequently demonstrated and the secretion in the cyst cavity is not sufficient in amount to cause distention. Furthermore, no reason is given for the bronchial stenosis. Although true cysts are considered congenital in origin, Pearson[76] held that some may develop postnatally, from aberrant rests of primitive tissue, or after some form of obstruction caused a distention of a portion of the lung tissue distal to it.

In considering the causation of congenital pulmonary cysts, a brief review of the embryology of the lungs may not be amiss. At the end of the fourth week of the embryo, a hollow evagination called the pulmonary groove appears on the esophageal portion of the primitive gut. From the hinter part of this groove, an outpouching soon develops from which the entire pulmonary system originates. The caudal end of this tube immediately develops two buds, the right and left; the right forms three buds from which spring the right bronchial branches and the three pulmonary lobes; the left develops only two buds from which spring the left bronchi and their ramifications, which ultimately form the two left pulmonary lobes. The divisions of these five buds take place rapidly by successive evaginations which eventually form the alveolar ducts, the atria, and the air sacs. The latter finally originate the compacted air cells which represent the ultimate branches of the air passages of the lungs. Broman[13,14] was able to demonstrate the rapid division of each bronchial ramification taking place even after birth. This process of division with the formation of multiple new buds dividing again and again continues until about the eighth year.

The causation of all spontaneous malformations falls into two large groups, internal and external. The internal causative factor is a defective constitution of the germ plasm, whether modified by inherent peculiarities of one or both parent cells by pathologic changes affecting the embryonic organism, or by impressions due to heredity or atavism. The possible hereditary influence on the causation of embryonic maldevelopment of the lungs is illustrated by Neisser's[68] 2 cases appearing in father and son, aged forty and nine respectively. Both patients had persistent symptoms of bronchitis and revealed dullness over the left lung from the angle of the scapula downward. Roentgen examinations in each case revealed similar findings which confirmed the author's diagnosis. Sandoz[83] described the necropsy findings in twin sisters both of whom were similarly distressed with increasing dyspnea, cyanosis

and cardiac insufficiency. Both patients showed analogous findings with small cavities and emphysematous blebs scattered throughout both lungs.

The recurrence of an ancestral feature or a reversion to racial characteristics that have been dormant through many generations not infrequently accounts for the existence of certain structural changes in the developing fetus. This racial inheritance is spoken of as atavism. The reappearance of the azygos lobe as a separate structure, which is always well developed in quadrupedal mammals and which is always present in man as a buried rudiment, is an example of atavism. Assuming that swim bladders appeared first and that the lungs were derived from them, a study of the comparative anatomy of the respiratory system and its evolutionary modifications reveals the ancestral structures of the respiratory apparatus in man, any feature of which may suddenly become dominant resulting in an atavistic anomaly or malformation. Beneke's[7] patient, who was a new-born infant, presented a left-sided diaphragmatic hernia and showed a large cystic accessory lung with its bronchus ending blindly at the stomach wall. Bert and Fischer[9] demonstrated a cystic accessory lung in a patient, aged sixty. Similar findings were observed by Meyer,[63] Lewisohn,[55] Springer,[88] Stoerk,[91] Dürck,[25] Wechsberg,[98] Wood,[101,102] Harrington,[38] and Mencarelli.[62] In all, there were 38 cases that at necropsy disclosed malformations other than the cystic disease of the lung. The most frequent of these congenital lesions (17 cases) was the presence of an accessory lobe or lung which harbored the cystic defect.

The external causes adversely affecting the development of the embryo include mechanical influences, such as traumatism and pressure; physicochemical factors, such as variations of the temperature and atmospheric pressure, insufficiency of oxygen, electrical influences and the effects of roentgen rays; poisons, such as corrosive poisons, organic or parenchymal poisons, blood poisons, nerve poisons; vegetable and mineral parasites, including microorganisms; disorders of nutrition and metabolism; and disturbances of the blood circulation. Pathological conditions of the fetal membranes, especially the amnion, are responsible for pressure effects. Trauma not only results in impaired nutrition due to extravasation of blood between the ovum and maternal tissues, but it has also been known to cause epithelial cysts which may arise at points of injury by the displacement of epithelial cells. Whether the tissue insult is the result of traumatism or pressure effecting an impairment of nutrition to the embryo or is initiated by other physical agents, such as heat, cold, electrical shock, toxic substances, etc., or whether it is caused by parasites, metabolic dyscrasias, or circulatory disturbances producing a deficient oxygen supply, the final result is the same, namely, a displacement of cells or an interference with the normal growth or development.

Because of these teratological influences,[77] various abnormal changes may take place. The terminal buds may cease to develop any further and may sometimes exhibit great dilatation and be converted into congenital bronchial cavities or cysts which may occupy a large part of the entire underdeveloped area. Wolman[100] believed that one or more buds of the developing bronchial tree in his patient became displaced or picked off, due to any one or a combination of abnormal influences, and "went on to develop into pulmonary tissue. Because of the lack of a channel for excretion, the differentiating bronchioles and alveoli soon became distended with fluid, which was apparently mucosal secretion, and thus followed the same laws as govern the growth of the closed epithelial cysts which appear occasionally in other parts of the body. Excessive proliferation of the bronchial walls seemed to have occurred at the expense of alveolar formation, since the alveoli were relatively so few in number."

That pulmonary cystic disease is due to

a developmental error or anomaly is now generally admitted, although many factors in the precise mechanism of its genesis are still unknown. The cyst wall may have the characteristics of bronchi, bronchioles, atria, infundibula or alveoli. This depends at what intrauterine age the developmental error or fetal inclusion occurred. In the eight months stillborn reported by Smith,[87] the multiple cysts appeared to be dilatations of the atria, the openings into the bronchiolar terminations, because he found no elastic or muscle fibers in the walls of the cysts. The malformation was not recent enough in origin to be dilated alveoli, inasmuch as these cells are not formed until the sixth fetal month. Most of the cases derive their origin from bronchial or atrial tissue. When derived from a bronchus or a bronchiole, the walls contain unstriped muscle, elastic and fibrous tissue and sometimes cartilage, sporadically arranged. The epithelial lining may be columnar, cuboidal or flattened. Frequently, the various types are observed in the same cyst and transitional forms may be present, or the multiple cysts in the same patient may be lined by the various types of epithelium. In de Lange's[51] case representing numerous large and small cysts, the smallest are lined with cylindrical epithelium, the medium-sized cysts with a cuboidal or squamous lining and the largest are almost denuded of epithelium. Similar findings have been reported in patients with multiple cysts observed by Stewart, Kennedy and James[90] and others. The columnar and cuboidal epithelium may or may not be ciliated. The nature of the epithelium may be profoundly modified by the increase in size or ballooning of the cyst as well as by the presence of infection, and does not, as a rule, exclude the possibility of a cyst being derived from bronchial or atrial tissue. The morphological appearance of the mucosa is often identical with the epithelium of bronchi or bronchioles. The cyst lining is often thrown up into small redundant folds, which assume a corrugated appearance and in some places form papillary ingrowths, a finding which suggested the adenoma theory of their pathogenesis. These rugae are seen microscopically to consist of a layer of epithelium supported by areolar fibrous tissue, and may be the result of post-mortem shrinkage. Furthermore, Wolman[100] was of the opinion that the theory of bronchial stenosis with distal dilatations as a likely etiologic basis for cyst formation is fallacious. He maintained that such delicately constructed projections are hardly considered a sufficient barrier to produce bronchial obstruction or stenosis with an accompanying dilatation distal thereto.

The cyst cavity is often traversed by fine delicate curving bands or strands of fibrous tissue. If these septa are firm and stout the cyst appears as trabeculated or multilocular. The cavity of the cyst usually contains a thin gelatinous or albuminous fluid with desquamated epithelial cells, or, if infected, pus, mucus and other products of infection are present. The cyst walls may be thin or thick depending on the size of the cavity and on its intraluminal pressure, as well as on the presence or absence of infection. In large ballooned cysts the walls are usually thin, and may rupture; the smaller cysts, as a rule, have firm walls and do not tend to perforate.

Of vast importance to the symptomatology and clinical course of the case is the presence or absence of a communication between the cyst and its neighboring bronchus or bronchiole. If such a communication exists, the contents of the cyst are evacuated and replaced by air. Such communications predispose to infection, and, sooner or later, pus not infrequently occupies the cyst space. However, a bronchial opening is not always necessary for the cyst to become infected. A surrounding infection or a pneumonic process may secondarily invade the cyst and infect its contents.

Cysts may be solitary or multiple, varying in size from a pinhead to a cavity which not only fills up the entire hemithorax but also encroaches upon the opposite side,

TABLE II

INCIDENCE OF THE TYPES OF CYSTS ACCORDING TO THE CLASSIFICATION SUGGESTED BY ANSPACH AND WOLMAN[3]

	Infants and Children	Adults	Total
Solitary Cysts			
Fluid cyst	21	13	34
Air (non-expansile) cyst	12	12	24
Balloon (expansile) cyst	21	3	24
Total number of solitary cysts	54	28	82
Multiple Cysts			
Fluid cysts	24	10	33
Air (non-expansile) cysts	27	85	111
Balloon (expansile) cysts	2	—	2
Total number of multiple cysts—	53	95	146

displacing the heart and mediastinal contents considerably. If the cysts are multiple, they may involve one or more lobes or lungs. Of the 228 cases in which mention is made of the type of cyst found, 82 were solitary or single, the remaining (146) being multiple (Table II). The right lung alone was involved in 40 per cent of the cases, the left in 37 per cent, and in 23 per cent the lesion was bilateral.

CLASSIFICATION AND CLINICAL TYPES

Daniel and Jezsovics[22] classify congenital cysts or congenital bronchiectasis as localized or diffuse. These may be agenetic, atelectatic or idiopathic, depending on what the investigator considered to be the supposed pathogenesis or etiologic basis of the lesion. Wood[101,102] groups all congenital cysts of the lung into two classes: (1) single or multiple cysts containing air or fluid and (2) diffuse degeneration resulting in the so-called honeycombed type of lung. From a clinical standpoint, the classification recommended by Anspach and Wolman[3] is very satisfactory because it offers an anatomical basis for the post-natal behavior of the various clinical types. This classification (Table III) is predicated on the assumption that all congenital cysts, whether solitary or multiple, are fluid-containing cysts at their inception and do not communicate with a bronchus or bronchiole. In Wolman's[100] patient, a six

TABLE III

SUGGESTED CLASSIFICATION OF CONGENITAL LUNG CYSTS ON THE BASIS OF POST-NATAL BEHAVIOR (ANSPACH AND WOLMAN[3])

- Congenital embryonic malformation of lung
  - Solitary fluid cyst (at birth)
    - No communication with bronchus → Solitary fluid cyst
    - Communication with bronchus
      - Free opening → Non-expansile air cyst
      - One-way valve mechanism at orifice → Expansile "balloon" cyst (reported in infancy only)
  - Multiple fluid cysts (at birth)
    - No communication with bronchus → Multiple fluid cysts
    - Communication with bronchus
      - Free opening
        - → Non-expansile Multiple air cysts
        - → Non-expansile trabeculated air cyst
      - One-way valve mechanism at orifice
        - → Large single "balloon" cyst (reported in infancy only)
        - → Trabeculated "balloon" cyst (reported in infancy only)

months stillborn with multiple cysts, the cavities appeared on microscopic study as dilated bronchi with alveolar offshoots. They communicated with each other but not with the bronchial tree, so that these communicating chambers formed a closed system or systems. Other writers have shown similar findings which were present at birth or early in life. Pappenheimer,[74] Grawitz,[36] Kessler,[45] Collins,[19] Tyson,[94] Smith,[87] Koeckert,[48] Melchior,[61] Hückel,[42] Swanson and his coworkers,[93] and others, have also described infants with fluid cysts.

Fluid cysts are not confined to infants. Desmeules and Morin[23] described a woman, aged sixty-three, who died of ulcerative-fibrous tuberculosis, and the necropsy revealed multiple congenital cysts in both lungs filled with clear fluid like spring water. In Kleine's[47] thirty-two year old patient, a fluid-containing cyst, the size of an orange, was found attached to the left upper lobe. There was no communication with the bronchus, and the cyst wall lined by simple flattened columnar epithelium showed no anthracotic pigmentation which indicated its congenital origin. Other adult patients with fluid cysts were described by Poiré and Chabaneix,[78] Krampf,[50] Rossi and Méndez,[82] Lehnhoff[53] and others. These cases disclosed no bronchial communication either during life or at necropsy. During life, bronchography showed the iodized oil to surround the cyst and not enter its cavity. On necropsy, no communicating channel was found on serial sections. Pappenheimer[74] injected the bronchial tree in his patient, post-mortem, with a solution of Berlin blue in gelatin. The dye filled all the lobes except for the area affected with cystic disease, where none of the colored gelatin was observed grossly or microscopically.

If the solitary fluid cyst ruptures into a bronchus, air and fluid make up the contents of the cyst and a fluid level is present. The fluid is then entirely replaced by air, and a solitary air cyst ensues. With a patent channel between the bronchus and the cyst during inspiration and expiration, the cyst remains stationary in size and is a non-expansile cyst. However, should the cyst walls compress the bronchial opening at the end of the inspiration or during the expiratory phase, the cyst tends to dilate or balloon due to the imprisoned air, and this enlargement classifies it as an expansile or balloon air cyst. The pressure of the cyst wall on the bronchial aperture produces a ball-valve effect allowing the ingress but not the egress of air with the result that the cyst distends or enlarges. This phenomenon is observed usually in infancy, as exemplified by the patients reported by Miller,[64] Parmelee and Apfelbach,[75] Croswell and King,[21] Jacobs,[43] Nelson,[69] and others.

In multiple fluid cysts at birth a similar mechanism obtains. When there is no bronchial communication, the cysts retain their fluid contents. When such a communication takes place, the type of the cyst depends upon whether the orifice is free or has a one-way valve effect. If the opening is unimpeded during both respiratory phases, they are non-expansile multiple or trabeculated air cysts. With a ball-valve obstruction at the orifice, the result may be either a large single balloon cyst or a trabeculated balloon cyst. The multiple trabeculated air cysts which communicate with a bronchus or bronchi are often designated as a honeycombed lung. Not infrequently, as in the case reported by Stewart, Kennedy and James,[90] multiple cysts of both lungs were encountered, some of which communicated with the main bronchial tree and contained air or pus; the others terminated blindly and contained fluid.

SYMPTOMS AND CLINICAL COURSE

The symptomatology of solitary cystic disease depends not so much on the histogenesis of the lesions as on their size, location, capsular strength, neighboring bronchus, contiguous lung tissue, and on the change in intrathoracic pressure. The presence or absence of infection plays an

important rôle. These patients are not only prone to infection but not infrequently succumb to it. Many cases go on for years, unrecognized and without symptoms; in others, symptoms are evident at birth. The symptomatology (Table IV) may be generally classified into two groups: cystic disease in infants in whom the balloon type of cyst predominates, and cystic disease later in life.

TABLE IV

FREQUENCY OF THE MORE COMMON SYMPTOMS

	Infants and Children	Adults	Total
Cough	36	72	108
Dyspnea	42	44	86
Expectoration	16	60	76
Cyanosis	31	19	50
Fever	9	22	31
Malnutrition	12	13	25
Thoracic pain	3	18	21
Hemoptysis	1	20	21
Weakness	2	10	12
Wheezing	6	3	9
Anorexia	5	2	7
Palpitation	1	6	7
Vomiting	5	1	6

The disease in infants and young children is quite unlike any other condition, and may be readily suspected and recognized. Some embarrassment in respiration is usually present. This may be so mild as to go unnoticed and may be evident only on exertion; or the attack of respiratory difficulty may be so severe as to cause alarm of a fatal issue. The marked breathlessness, often coming in attacks, is observed usually in the expansile or balloon cysts in which the air becomes trapped and the cyst enlarges, compressing the lung, flattening the diaphragmatic cusp, and displacing the mediastinal structures, including the heart, to the opposite side. Relief may not be obtained until the ball-valve effect at the bronchial orifice is overcome, allowing a deflation of the cyst, or unless the intracystic pressure is reduced by thoracentesis. The cyst may rupture into the pleural space with the result that a pneumothorax ensues, as clearly demonstrated in the patients reported by Burghard,[16] Oechsli and Miles,[71] and others. The difficulty in breathing is, not infrequently, in the form of wheezing, as in the cases reported by Tyson,[94] Cabot,[17] and others. Associated with a cough, the wheezing may suggest a diagnosis of asthma and entirely mislead the attending physician.

Accompanying the dyspnea, varying degrees of cyanosis are present. Cyanosis may be constantly present, or may only be noticed during exertion such as crying. Cough is not always a prominent symptom. A non-communicating cyst, if not too large, may cause no cough, and for that matter, no symptoms at all. As in my case of a solitary non-expansile fluid cyst in a five week old infant, the finding of the cyst was entirely accidental and discovered on a routine roentgenoscopic study when the patient was examined for failure to gain weight. Cough is present in infants with cysts that have a bronchial connection, and becomes a rather prominent symptom in infected cysts. Expectoration also depends, therefore, on a bronchial communication and on the presence of mucopus in the cyst cavity. It is of interest to note that, not infrequently, a diagnosis of a rupture of the cyst into a neighboring bronchiole can be made by a history of a sudden attack of coughing, with the expectoration of mucoid or gelatinous material, which may or may not be blood-tinged or brown in color. This occurred in one of my cases and also in a seven week old infant reported by Anspach and Wolman.[3] An elevation in temperature depends on the presence or absence of infection. As a rule, it is not high because the purulent material is well localized in the cystic cavity.

The infants with cystic disease of the lung may be well nourished and show no other congenital lesion. In 30 of the collected cases in infants and children, however, malnutrition was sufficiently pronounced to be recorded by the examining physician. They may be poor feeders, gain

slowly in weight, and may be generally below par. A slight secondary anemia is not infrequently observed. Other congenital defects may be discovered during life or on necropsy. Koontz's[49] case in a twelve day old infant showed hypertrophic pyloric stenosis and cardiac hypertrophy and dilatation. In the case reported by Oechsli and Miles,[71] a young male adult developed a typical Froelich's syndrome in addition to his chest pains, dyspnea and cyanosis. Necropsy revealed multiple air cysts, hypoplasia of the thyroid and pituitary glands and an enlarged thymus.

In older children and adults the balloon type of cyst is seldom seen. Although Anspach and Wolman believed that this type occurred only in infants, Wood's[101,102] case illustrates a notable exception. A male adult, aged twenty-six, suffered for two years with progressive palpitation, dyspnea and syncopal attacks. He was suddenly seized with an attack of severe pain in the chest, marked dyspnea and air hunger which lasted for two hours. Physical signs revealed an emphysematous thorax with faint breath sounds which were suppressed over the right lower lobe. Wood concluded that this case had presumably a spontaneous pneumothorax or a temporary bronchial occlusion. In either event, the cause was an expansile or balloon cyst with the trapped air producing the severe syncopal attacks. A fifteen year old patient with a solitary expansile air cyst in the right lung was reported by Cremer,[20] who observed that it is rare for a patient to attain this age with a balloon cyst. True fluid cysts are also less common in adults than in children. In older patients, solitary air cysts, infected or not, and diffuse multiple cysts, often described as honeycombed lung, predominate (Table II). The cysts may be symptomless if they are not sufficiently large to cause compression of the surrounding lung and important structures in the thoracic cage, such as cardiac displacement. Dyspnea is also a rather prominent symptom in most cases, either coming in attacks or persisting for long periods of time. The varying degrees of breathlessness depend on the patient's activity or exertion. Frequently, any physical effort is interdicted to avoid shortness of breath. Cough, expectoration and pain in the chest are frequent complaints, and also require attention and care. Palpitation, which at times may be severe, is noted especially in those cases with large cysts accompanied by cardiac displacement. Blood-streaked sputum and, more rarely, frank hemoptysis, may be met with and may be a prominent symptom, leading to the suspicion of a tuberculous lesion. Profuse hemorrhage was noted in the cases reported by Eloesser,[29] Lehnhoff,[53] Wood[101,102] and others.

Because of the roentgen findings of one or more circular air shadows not infrequently observed in the upper lobes and the symptoms of respiratory disease often accompanied by more or less hemoptysis, many patients have been diagnosed and treated as tuberculous. Herms and Mumme,[40] Pollock and Marvin,[79] Oechsli and Miles,[71] Siems,[86] Daniel and Jezsovics,[22] Dethmers,[24] Bönninger,[11] Steinmeyer,[89] Mumme,[66] and Moorman[65] have described patients with congenital cystic disease who have been treated for tuberculosis, notwithstanding repeated bacteriological tests. The 6 patients with congenital cysts reported by Lenk[54] were considered tuberculous and treated from several months to several years in sanatoria in spite of the many negative sputum examinations, until the true nature of their illness was discovered.

If free from secondary infection, cystic disease is not incompatible with long life, and death ensues from some intercurrent malady or when undue stress or strain is suddenly put upon the patient, such as an operative procedure. Garnier[34] reported a patient, aged thirty-eight, who died with suffocative symptoms directly after giving birth by cesarean section. The necropsy revealed a honeycombed appearance of the right apex with dilated bronchi. Her attending physician had no knowledge of

any symptoms, and the patient had never given him any history of a bronchial disease. Not infrequently, patients with mildly infected cysts, draining satisfactorily, may live for many years in relative comfort, with symptoms simulating an acquired bronchiectasis. As Eloesser[29] pointed out, a history of long continued cough and expectoration dating from childhood, with signs of chronic bronchial suppuration but with no demonstrable etiology, should arouse suspicion of congenital cystic disease in an adult.

There are no physical signs which are characteristic of congenital cystic disease. The objective findings naturally depend on the classification or type of cyst or cysts, on its size (expansile or non-expansile) and contents (fluid or air). The respiratory rate may be increased; the pulse rate normal or slightly rapid. Elevation in temperature depends on the presence of infection, and is seldom high. The affected side of the chest, especially in infants and children, may bulge, and its respiratory excursions are often limited. Slight impairment of resonance is elicited over the affected lobes, and breath sounds are diminished and even absent. Vocal fremitus and vocal resonance are also decreased. Râles may or may not be heard. In large cysts, the heart is displaced to the opposite side and the diaphragmatic cusp is depressed. Râles, impaired resonance and diminished breath sounds may be elicited over the compressed portion of the surrounding lung. In the large cysts or in the expansile or balloon type of cyst, the physical findings of pneumothorax are present with the heart displaced to the opposite side and the diaphragmatic leaf depressed on the affected side. In the multiple cystic cavities, the signs of acquired bronchiectasis may be elicted. Stewart and his coworkers[90] described a sound identical with a pleural friction rub heard over the entire chest of a patient with multiple cysts. On necropsy, it was found that this friction-like sound was not caused by roughened pleura, but depended for its production on sounds transmitted through the distended bronchi or on crinkling of the subpleural atelectatic area that was present. The diagnostic value of this auscultatory sign is not known.

ROENTGENOLOGICAL FINDINGS

The roentgen study presents by far the most important evidence in the diagnosis of congenital pulmonary cystic disease. Wood[101,102] states that a large percentage of all cases can be so diagnosed. In solitary fluid cyst, the roentgenograms disclose the presence of an ovoid opaque area, situated within the parenchyma of the lung. The opacity persists unchanged in size or appearance on successive studies taken over a long period of time. However, if rupture into a neighboring bronchus takes place, the roentgen study made shortly thereafter shows the presence of a horizontal fluid level, above which a pocket of air is observed. Later, when the fluid is entirely replaced by air, the cyst wall is usually detected, appearing as a rather thin capsule. Not infrequently, fine strands or thin bands are seen traversing the structureless cystic space in wide sweeping curves, clearly demonstrated in the roentgenograms of Pollock and Marvin's[79] patient. In the balloon or expansile type, the cyst may occupy the entire half of the chest, and even overlap the mediastinum and heart. With the displacement of the heart and mediastinum to the opposite side, the cusp of the diaphragm on the affected side is depressed. The roentgenoscope may reveal an increase in illumination within the cyst during inspiration. The appearance at first glance resembles a complete pneumothorax from which it must be differentiated, soon to be discussed.

In patients with multiple cysts containing air or fluid, the findings are similar to those observed in solitary lesions, except that they are usually smaller and may be scattered in one or more lobes or lungs in irregular fashion. In the type recognized as honeycombed lung or multiple trabecu-

lated cysts, the roentgen findings are not unlike an acquired bronchiectasia, from which it may not be readily separated.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

The symptoms, together with the inconclusive physical findings in the lungs, should make the physician cyst-conscious. Although there is no pathognomonic syndrome, the history of recurring attacks of severe dyspnea with cyanosis is sufficiently important, especially in infants and children in the absence of any evident cause, to suggest the possibility of cystic disease of the lungs. The roentgenological findings are most essential in all cases and often establish the diagnosis. Further diagnostic methods may become necessary but are often superfluous. The bronchoscope may locate the bronchial stenosis or the communicating bronchus. If the cyst is infected, the purulent fluid in the bronchiole may be found. The injection of iodized oil into the affected area or areas demonstrates the cystic cavity if it has a bronchial outlet, or portrays the oil around the cyst if no bronchial communication is present. Thoracentesis releases air under pressure, or, as in fluid cysts, a glairy, milky, sterile liquid is obtained. An artificial partial pneumothorax for diagnostic purposes often rewards the physician with roentgenograms that clearly portray the cystic shadow in the partially collapsed lung. As the lung recedes from the thoracic wall following the injection of air into the pleural cavity, the wall of the cyst lying within the lung parenchyma is often brought into view, whereas prior to the induced pneumothorax the cyst outline may be obscure. An example, among others, is Wilson's[99] case in a female, aged thirty-seven. Induced pneumothorax demonstrated the wall of the cyst lying in the partially collapsed lung. In one of Wood's patients, a male infant aged two years four months, in whom the physical signs and roentgenograms gave the diagnostic impression of pneumothorax and who was afforded no relief by the aspiration of air, further roentgen study, after an induced pneumothorax, clearly showed a cystic cavity within the partially retracted lung, the wall of the cyst being forced away from the thoracic wall by the air in the pleural cavity. Direct operative exploration of a suspected cyst with a biopsy of its wall showing an epithelial lining and presenting the characteristics of some portion of the bronchial tree, renders the diagnosis absolute.

Inasmuch as the diagnosis rests so heavily on the roentgen examination, the lesions that so closely resemble cystic disease, roentgenologically, must be considered and differentiated. An acquired cystic condition, as echinococcic cyst, may be recognized by the complement fixation test and by the presence of an eosinophilia. Urticaria not infrequently is present. An echinococcic cyst usually occupies the lower right lobe, and, after rupture, the sputum examination shows the characteristic hooklets. Dermoid cysts, teratomas of the mediastinum and mediastinal cysts usually begin after puberty and originate in the mediastinal spaces. They may rupture into the lung or bronchus or pleural cavity, and often form dense adhesions to the neighboring structures, which result in a deforming appearance of the thoracic contents. Dermoid cysts may demonstrate the presence of teeth or bone on the roentgenograms, or hair may be found in the expectoration. Hydatid cysts are also usually mediastinal in origin and produce no or very little dyspnea. If rupture occurs, the watery nature of the fluid is rather characteristic, and hooklets and fragments of membrane may be present in the sputum. Solid tumors may offer some difficulty at first. A chondroma or a ganglioneuroma presents sharp borders, and is seldom confused with a cyst filled with fluid, the bordersof which are rather poorly defined as compared to a tumor growth. Diaphragmatic hernia or eventration can

be readily excluded by the oral administration of barium. In addition, gurgling sounds are frequently heard on auscultation.

Congenital cystic disease of the lung must be differentiated from the more frequent conditions such as empyema, localized fluid, partial or generalized pneumothorax, lung abscess, tuberculous cavities and acquired bronchiectasis. In encapsulated fluid and empyema, lateral and stereoscopic roentgenograms show the lesion to be outside of the pulmonary tissue. The nature or character of the aspirated fluid contents often helps in the differentiation. In uncomplicated congenital cysts the aspirated specimen resembles amniotic fluid. It is slightly milky or albuminous in appearance, and may be viscid or glairy. There is no growth on culture. Microscopic examination often reveals ciliated columnar epithelium and, occasionally, goblet cells.

In excluding localized or partial pneumothorax, the air pocket is without the lung, usually appearing irregular in contour, and showing no surrounding wall. Generalized pneumothorax also shows the air outside of the lung which collapses toward the root, where it appears as a stump. There is no capsule surrounding the air. Roentgenoscopically, no increased illumination within the imprisoned air space is observed on inspiration. In solitary balloon cyst, the moderately thin capsule is visualized, and the lung contains the cystic cavity which compresses the pulmonic tissue in all directions, namely, toward the apex, toward the base and costophrenic sinus, and toward the lung root. Thus, atelectatic lung tissue is observed clouding the apex and costophrenic sulcus; and the lung root, instead of appearing as a large stump due to the collapsed lung as observed with a complete pneumothorax, is thinned out and displaced to the opposite side together with the heart and mediastinum. Furthermore, the history of sudden onset and the constantly changing physical signs and roentgenological appearance of the lungs suggest the diagnosis of spontaneous pneumothorax. The roentgen findings in cystic disease usually remain unchanged over a long period of time. Pollock and Marvin[79] note that the presence of fine strands or linear bands, which traverse the cystic space, appear in wide sweeping curves and not in straight lines, as one would expect to find in pneumothorax with associated pleural adhesions. Absolute separation of the two conditions is made by the induction of an artificial pneumothorax, which, roentgenologically, demonstrates the outer lung border and reveals the cystic area within the pulmonary tissue. In congenital pneumothorax, which is a very rare condition, the findings are the same as in the acquired form and can be similarly excluded.

In the congenital honeycombed type of cystic disease, considerable difficulty may be encountered in differentiating it from the acquired form of bronchiectasia, and, not infrequently, the absolute diagnosis must be deferred until the necropsy study shows an absence of pigment in the involved bronchial walls, which classifies the lesion as congenital in origin. Cysts are usually larger, more spherical, and more discrete than bronchiectatic cavities. As Eichhorn[27] pointed out, they are distributed in the lung in an absolutely irregular manner, in contrast to bronchiectasis following contractive processes. Demonstrable bronchial communication of a true cyst is sometimes absent, but is always readily found in bronchiectasis. Bronchoscopy and bronchography may aid in the differentiation. The presence of symptoms since birth or early childhood, in the absence of a history of a severe respiratory infection, indicates the probability of an underlying congenital malformation of the lungs.

Single or multilocular cysts which become infected simulate lung abscess. Due to the surrounding pneumonitis, the abscess walls appear thicker than in cysts. A painstaking history may aid in arriving at the correct diagnosis. Operations for supposed empyema or lung suppuration have been responsible for the diagnosis of lung

cyst as the underlying lesion as in Eloesser's[28] patient, a student twenty years of age, and in 2 patients reported by Pearson.[76] The biopsy of the cyst wall, which showed the characteristic bronchial origin, confirmed the diagnosis of a congenital cyst as the underlying pathology. The roentgenologic differentiation between tuberculous cavities and cysts is determined chiefly by the walls of the latter and by an absence of associated changes usually seen in a Koch infection.

COMPLICATIONS

Assuming that all congenital cysts are fluid at birth, then the many variations of this finding may be considered as complications or sequelae, such as the establishment of a perfect or imperfect communication with a bronchus and a replacement of the fluid contents by air. From the practical standpoint, however, two serious complications may be considered, namely, infection and rupture. As mentioned above, infection occurs from the bronchial tree or from the adjacent lung, and is commonly met with, especially in older children and adults. The expansile type of cyst, due to its increased intraluminal pressure, may rupture into the pleural cavity and result in a pneumothorax which produces an attack with alarming symptoms, and, not infrequently, terminates fatally. The spontaneous rupture of a large air cyst is most commonly seen in infants and young children, as portrayed by Fleming's[31] case in an eight year old girl, in the fifteen months infant reported by Gamon and Mallory[17] and by others. Rarely, however, thin-walled cysts, especially situated at or near the surface of the lung of adult patients, may rupture into the pleural cavity and produce a pneumothorax. Oechsli and Miles'[71] case, a male, aged twenty-two, suffered a simultaneous spontaneous pneumothorax with bilateral collapse twice and unilateral collapse once, with complete re-expansion each time. He eventually died of cardiac failure secondary to multiple bilateral pulmonary cysts, many of which were superficially located and appeared like blebs. Necropsy showed the cavities to be free from pigment.

PROGNOSIS

In infants and children, the outlook is grave. In other patients, the condition is not incompatible with long life, and not infrequently produces very few symptoms. Rarely, the cyst may empty itself by rupturing into a neighboring bronchus or bronchiole, and its walls finally collapse and absorb, with the eventual, complete recovery of the patient. In one of my cases and in the one reported by Croswell and King,[21] these events took place, and further roentgen studies showed a perfectly normal lung. Vollmer[97] reported a solitary expanding air cyst in an infant ten months old with symptoms of dyspnea, cyanosis, cough, vomiting and night sweats of four months' duration. The tuberculin test was negative. On thoracentesis, air escaped under pressure, and improvement in the clinical course was noted. Finally, subsequent roentgenograms showed a disappearance of the large cystic shadow. Although the infant completely recovered, Vollmer did not believe that the single puncture should be accredited with the cure. The single balloon cyst in a seven month male infant reported by Zarfl[103] caused violent attacks of dyspnea, cyanosis, fever, cough and expectoration for many weeks. Thoracentesis was withheld, and after the subsidence of the symptoms the cyst appeared smaller on roentgen examination. After five months, the air pocket spontaneously disappeared.

However, an analysis of the reported cases shows a very high mortality, especially in infants and children. In the collected series (Table v), congenital cystic disease is given as the cause of death in 56 infants and children and in 35 adults. The gravest outlook is in the expansile type of cyst, which causes severe attacks of dyspnea and cyanosis, often terminating fatally. Not only the age of the patient and the type and size of a cyst or cysts, but

TABLE V

CAUSES OF DEATH

	Infants and Children	Adults	Total
Congenital Cystic Disease	56 (60.2%)	36 (53.7%)	92 (57.5%)
Pneumonia	22 (23.6%)	7 (10.4%)	29 (18.1%)
Tuberculosis	2 (2.1%)	3 (4.4%)	5 (3.1%)
Cardiac failure	2 (2.1%)	2 (3%)	4 (2.5%)
Other causes	11 (11.8%)	19 (28.3%)	30 (18.8%)
Total	93	67	160

also the presence or absence of infection play a very important rôle in the prognosis. In the presence of a pulmonary malformation, these subjects fall an easy prey to respiratory infection, and are prone to succumb. However, this is not always the case, and older children and adults may survive several pneumonic inflammations and continue with relatively few symptoms for many years. With multiple infected cysts, they simulate the clinical course of patients with bronchiectasis.

TREATMENT

Although therapy depends on the character or type of cyst or cysts, it has been on the whole, unsatisfactory. Rarely, recovery may be spontaneous, with no therapeutic procedure. Cysts with few or no symptoms require no special form of treatment. These patients may remain well and comfortable, with the physical signs and roentgenological findings unchanged. Wood,[101 102] Steinmeyer,[89] and others, obtained some relief of symptoms by restricting the activity of their patients. There was a reduction in the number of attacks of dyspnea, cyanosis, pain and palpitation, and, in 2 of Wood's patients, the blood-tinged sputum entirely cleared up.

Judicious aspirations of air in infants and young children during an attack of severe dyspnea and cyanosis may prevent a fatality and, not infrequently, relieve the immediate symptoms. Many patients, however, have not been so fortunate, but the varying degrees of relief that have been obtained by aspiration warrant its continued use. The insertion of a one-way cannula allowing only the egress but not the ingress of air has been tried by Miller[64] and by Croswell and King[21] with only temporary improvement. In the patient reported by Croswell and King, the instillation of lipiodol, after a severe reaction, resulted in a collapse and absorption of the cyst, followed by a complete cure. As a rule, the presence of infection complicates the treatment of the condition, and a spontaneous cure becomes a remote possibility. The treatment for multiple cysts which are infected is similar to that of acquired bronchiectasis. Conservative measures, such as postural and bronchoscopic drainage, vaccine administration, etc., are of little avail.

In an effort to collapse the cystic cavity or to destroy its secreting membrane, the local application of irritating or sclerosing chemicals has been attempted with indifferent results. Swanson and his collaborators[93] injected formaldehyde solution through a fistulous opening, resulting in noticeable diminution in the size of the cyst, but, unfortunately, the child died later after a bronchoscopic examination. Adams[1] suggested a similar procedure, using silver nitrate solution, and advised the eradication, if possible, of all chronic foci of infection, such as infected nasal sinuses. Other investigators have tried without success to produce an occlusion or atresia of the bronchus leading to the cystic portion of the lung, in an effort to collapse that portion of the lung, and cause a subsequent absorption of the air. Adams

recommended the direct application of 35 per cent silver nitrate to the bronchial mucosa through a bronchoscope as an effective sclerosing substance. Phrenicectomy and induced pneumothorax, of great help in the treatment of tuberculous cavities, have failed to collapse congenital cystic cavities. Rib resection has helped in the treatment of infected cysts, but permanent fistulas have resulted because the cyst is not removed. Graham[4] among others has performed a partial thoracoplasty without materially affecting the size of the rigid cysts. The congenital cystic mass was marsupialized by Neuhof[70] and by Lilienthal[56] with marked clinical improvement. However, these patients have a permanent fistula, which required the insertion of a tube with a one-way safety valve to prevent refilling of the cyst.

The surgical procedures that offer the best hope for eventual cure are extirpation of the cyst or lobectomy. At the present stage of intrathoracic surgery, such intervention is of course attended with marked difficulty and grave danger, but is justifiable in selected cases. Because of the multiple adhesions, especially of the diaphragm, and because of the large vessels encountered at the hilus, dissection of the cyst and thorough hemostasis are not easy. Sultan[92] removed a suppurating cyst in the right upper lobe in a female, aged twenty-three, who died of postoperative shock or embolism. Sauerbruch[84] extirpated the cyst or resected the diseased lobe in 6 patients, 5 of whom were cured and one died of postoperative shock. Eloesser[28] performed a lobectomy in a student, aged twenty, with multiple infected cysts in the left lower lobe with complete recovery. Harrington[38] operated on a large congenital cyst in a nineteen year old female by the transpleural route and a large pus-containing cystic azygos lobe from the posterior mediastinum in a thirty-seven year old woman. Both patients recovered and have remained well for over a year. Melchior[61] removed successfully what he considered to be a dermoid cyst from the left lung of an eight year old female. The specimen, however, proved to be a tracheobronchial cyst of congenital origin. A large cyst of an accessory lobe lying in the mediastinum was operated on by Flemming-Møller[32] with complete recovery of the patient.

Recently Sauerbruch[85] reported the results of surgical intervention in 58 cases with congenital bronchiectasis: 6 died as a result of the operation and 51 were cured without a fistula. He expressed the opinion that local congenital malformations capable of leading to so grave a condition as bronchiectasis are best treated by a radical removal of the entire lobe, which he performs in two or more stages without infecting the pleural cavity and without retraction of the bronchial stumps. In 2 of the cases he removed the entire lung. Although radical removal is not feasible in bronchiectasis of inflammatory origin, he concluded that extirpation of the involved lobe is the rational treatment of congenital bronchiectasis. He is convinced that it is the method of choice and should be performed early, before the secondary alterations have time to develop.

In the final analysis, the cure for this malformation is its successful extirpation, and it remains for future thoracic surgery to meet the challenge and attain this goal with minimum risk.

REPORT OF CASES

Case 1.*Baby boy S., born November 7, 1931; birth weight, 3 pounds 9 ounces. On the fifth day, the infant had frequent attacks of cyanosis with shallow respirations. Examination of the chest disclosed slight impairment of resonance and râles in the lower left thoracic region. No cardiac murmurs were heard. On November 24, there was increased vocal fremitus in the right middle lobe.

Roentgen examination (Fig. 1) on November 24 revealed a triangular area of opacity in the right middle lung field. The impression was that of congenital atelectasis. A second set of films (Fig. 2) were taken on December 2 and

*This case is reported through the courtesy of Dr. Abraham Kantrowitz, Pathologist of the Beth Moses Hospital, Brooklyn, N. Y.

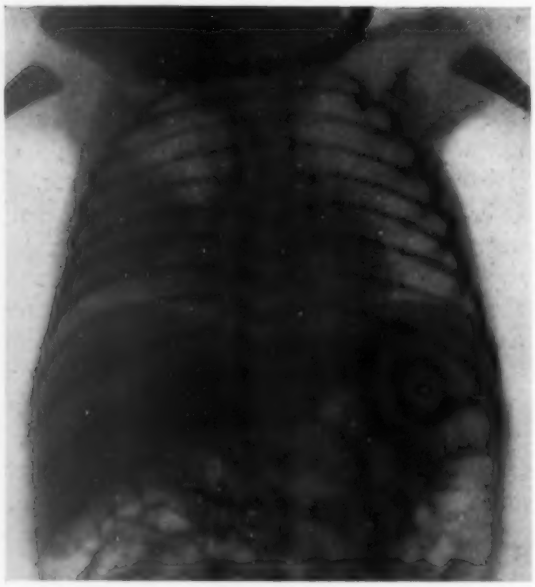


FIG. 1. Case 1. Roentgenogram taken at the age of two weeks reveals a wedged-shaped or triangular area of opacity occupying the middle of the right lung field. The pulmonic apex and base as well as the costophrenic sulcus appear clear. The diaphragm is dome-shaped and lies in a normal position. The mediastinal contents are not shifted. The roentgen impression is partial atelectasis of the right lung.

the roentgen findings were practically unchanged.

On December 31, examination revealed a cleft palate. On January 8, 1932, signs of pulmonary edema developed, the baby became moribund and expired at the age of two months. The weight at death was 3 pounds 6 ounces.

Post-Mortem Findings. Gross Description. The body was that of a maldeveloped, malnourished, cachectic appearing new-born baby, with dried skin, sunken cheek bones and wizened face. There were no other external evidences of abnormality. Upon opening the mouth, a bilateral cleft palate was noted. After entering the peritoneal cavity, the diaphragm was found to be at the level of the fifth interspace on the right side; the fourth interspace on the left.

Lungs. The right pleural cavity was almost completely obliterated by rather firm, vascularized, fibrinous adhesions, with the exception of the base, posteriorly, and the apex, anteriorly. The left pleural cavity presented no abnormalities except for a very small area of dark red, roughened pleura over the lower part of the upper lobe, anteriorly. The right lower and middle lobes were firm and dark red. On cross section, they presented a fleshy appearance with a homogeneous dark red color. The apex of the right upper lobe appeared normal. The remainder of the right upper lobe, which was grayish-white in color, was diffusely firm and airless with no evidence of crepitation. In the paravertebral region, there were two pinhead-sized, dome-shaped elevations, whiter than the rest of the lung surface and somewhat cystic in consistency. On cross-section, grayish-yellow purulent material was seen immediately beneath the pleura. Cross-section through the upper lobe (Fig. 3) portrayed a normal appearing apex with the remainder of the lung replaced by a honeycombed network of cavities which ranged from 1 to 2 mm. in diameter. The trabeculae had a grayish appearance. The cells contained a grayish-yellow purulent material. The smears showed innumerable gram-positive diplococci which, on culture, proved to be a *Streptococcus anhaemolyticus*. The bronchi and interstitial septa were not prominent. There was no evidence of connections between the main bronchi and the cystic spaces within the lung. The left lung, except for firm, depressed, dark red, homogeneous areas of fleshy consistency in its lower lobe, paravertebrally, presented no abnormal findings. The bronchi showed no changes.

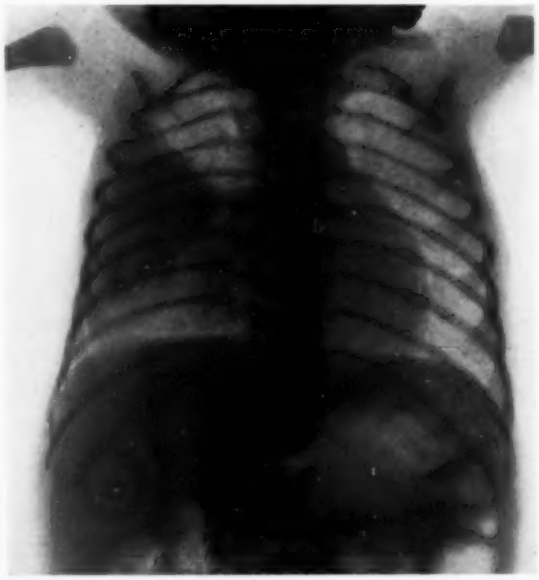


FIG. 2. Case 1. Roentgenogram taken ten days later shows no change in the appearance of the lesion in the right lung. Although the heart is not drawn to the affected side and the diaphragmatic leaf is not elevated, atelectasis appears to be the only tenable impression. The findings at necropsy, which revealed the lower two-thirds of the right upper lobe studded with innumerable densely compact small cysts filled with exudate and occupying airless lung tissue and separated from the normal crepitating apex by a sharply demarcated fibrous band, readily explain the dense triangular shadow portrayed on the roentgenograms.

Microscopical Findings. Sections of the honeycombed lung (Figs. 4 and 5) revealed the cavities to be intercommunicating and filled with polymorphonuclear leukocytic exudate. The cysts were lined by a unicellular layer of ciliated high columnar epithelium resting on a well-defined elastic membrane. The stroma was infiltrated with mononuclear and polymorphonuclear cells and also contained dilated capillary blood vessels. The contiguous pulmonary tissue showed a polymorphonuclear exudate in the bronchi and bronchioli with a compression of the alveoli, the septa of which contained polymorphonuclear leukocytes. A few alveoli contained fibrin, polymorphonuclear leukocytes and vacuolated macrophages.

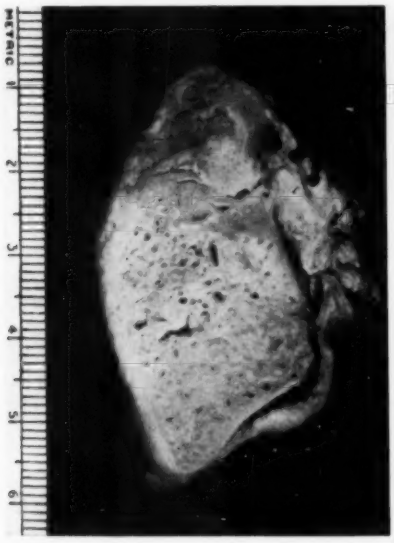


Fig. 3. Case 1. Gross specimen of right lung shows the honeycombed appearance of the lower two-thirds of the upper lobe. The apex presents normal lung architecture. The dense fibrous band which separates the normal apex from the remaining portion of the lobe harboring the cystic defects is better seen on the posterior aspect of the specimen.

Heart. The heart was normal in size. The auricular and ventricular cavities showed no abnormalities, and no anomaly of the ventricular septum was present. The foramen ovale and the ductus Botalli were patent. The myocardium appeared glassy and somewhat fragile, tearing rather easily. No pericardial changes were observed. The valves and aorta were likewise negative.

Liver. The liver appeared rather large and presented an edematous glassy surface on cross section, with indistinct lobular markings. The bile ducts which were patent presented no abnormalities, and the portal and hepatic vessels were also negative.

Spleen. The spleen was enlarged to about twice its normal size and was moderately firm in consistency. The dark red pulp scraped with moderate ease. The splenic artery and vein showed no changes.

Pancreas. Negative.

Fig. 4. Case 1. Low power magnification (40×) shows the multiple cysts honeycombing the lung parenchyma.

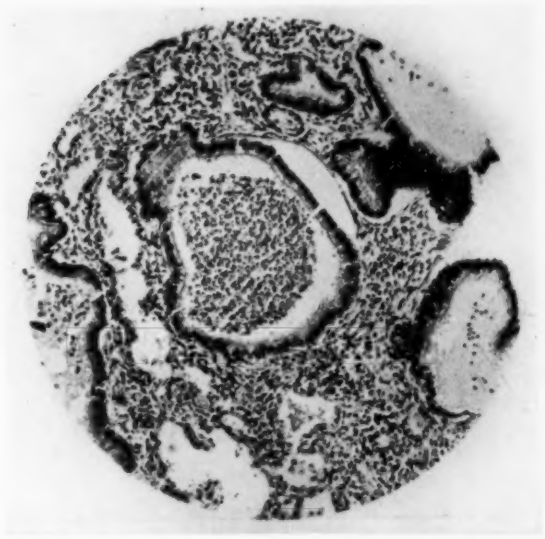
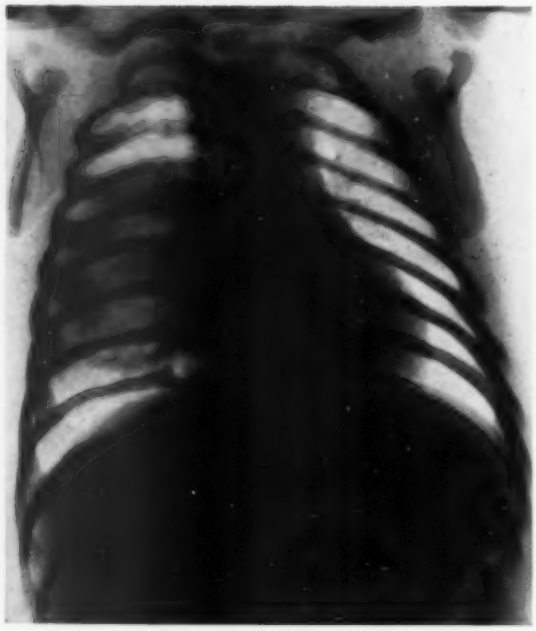


Fig. 5. Case 1. High power magnification (300×) demonstrates the single layer of ciliated high columnar epithelium resting on a well-defined elastic membrane. The cavities which are filled with polymorphonuclear leukocytic exudate appear to communicate with one another but not with a bronchus or bronchiole. The contiguous lung tissue shows polymorphonuclear exudate in the bronchi and bronchioli with compression of the alveoli.



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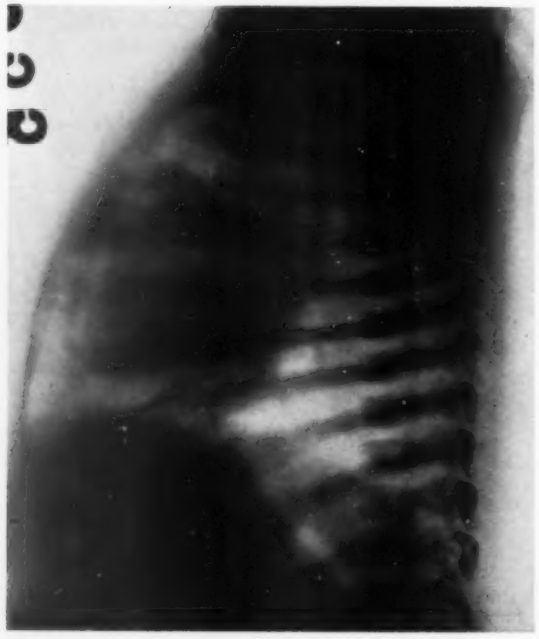

B

FIG. 6. Case II. *A*. Roentgenograms taken at the age of five weeks show a large dense ovoid shadow occupying two-thirds of the right pulmonic field, the apex and base of which are clear. The heart is not displaced, and the diaphragm appears normal. *B*. In the lateral aspect, the globular opacity is partly merged with the cardiac shadow from which it can be distinguished on the original films. The mediastinal spaces are not encroached upon; the opacity lies intrapulmonary. The roentgen impression is a solitary fluid cyst.

Adrenals. No changes.

Thymus. The thymic remnant was very small and presented a fatty, rather than a cellular appearance.

Genitourinary Tract. The kidneys were normal in size, cyanotic in appearance and flabby in consistency. The capsules stripped with ease, revealing fetal lobulations. Cross-section presented a glassy surface with indistinct corticomedullary markings. The pelvis, ureters and bladder showed no changes. The testes were negative.

Gastrointestinal Tract. No changes.

Diagnosis. Congenital cystic lung (fetal bronchiectasis), right upper lobe; severe degeneration of all the viscera; patent ductus Botalli and foramen ovale; cleft palate; cachexia.

Comment. The symptoms of dyspnea and cyanosis did not begin before the infant was five days old. Physical findings were indefinite until the end. The roentgen impression of partial atelectasis, although incorrect, was not entirely unjustified, notwithstanding the fact that the heart and diaphragm were not displaced to the affected side. The dense homogeneous shadow, as portrayed on the roentgenograms, corresponded to the innumerable, closely compact small cysts filled with exudate and lying in airless lung structure. The apex of the upper lobe and the lower two lobes showed normal lung architecture. Sections disclosed no communication between the cysts and the bronchial system. The cavities had thin walls which consisted of ciliated columnar epithelium and an elastic membrane, and were probably of bronchogenic origin. Other congenital lesions were also noted, such as a cleft palate and a patent foramen ovale and ductus Botalli.

CASE II. R. S., a male infant, aged five weeks, was referred for roentgen examination by Dr. Jacob L. Stein. The child was brought to the doctor for insufficient gain in weight. There was no history of any illness. Labor was normal and the delivery spontaneous. The infant cried lustily at birth. His birth weight was 7 pounds 4 ounces. At the age of five weeks, he weighed 8 pounds 4 ounces. The child was well devel-

oped and on physical examination revealed no pathology, either in the chest or elsewhere. The thorax was symmetrical and respirations were normal. Both lungs were apparently negative to percussion and auscultation. Routine roentgenoscopic examination of the chest disclosed a large, globular dense shadow occupying the middle of the right lung bed.

The roentgenograms (Fig. 6) confirmed the presence of a well-circumscribed opacity in the right pulmonary field occupying about one-half of the lung space. The pulmonary apex and base were clear, and the left lung bed was normal. The heart and mediastinal structures were not displaced and the diaphragm was not depressed. The lateral view showed the globular opacity lying within the lung structure and not part of or connected with the mediastinum or pleural cavity. The roentgen impression was a congenital solitary fluid cyst of the right lung.

The patient was again roentgenographed ten days later. In the interim, he had gained 1 pound 5 ounces. However, the mother gave the history that on the previous day the child had coughed up brownish fluid during an intense coughing attack; there were no other symptoms. The temperature was normal, breathing not rapid and cyanosis absent. The intradermal tuberculin test (Mantoux) was negative up to 5 mg. The roentgen study (Fig. 7) at this time portrayed the same well-defined opacity in the right lung bed, except that in its upper half a clear radiotransparent zone was present and a definite fluid level separated this area from the density in the lower half. The opinion was ventured that the fluid cyst had ruptured into a bronchus or bronchiole at the time that the child had the bout of coughing and raised the brown viscid fluid, with the result that part of the fluid contents of the cavity was replaced by air.

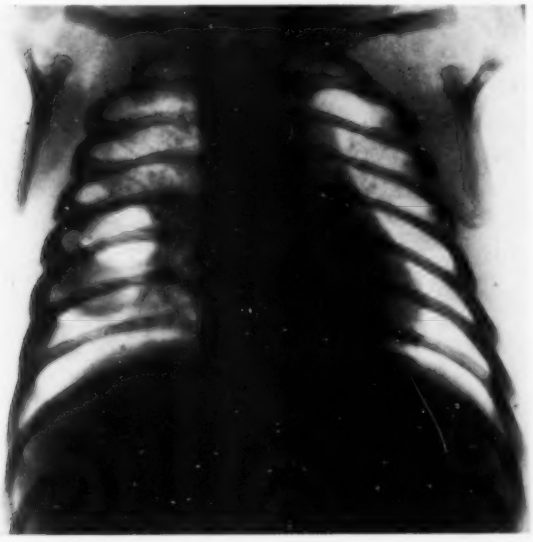

Fig. 7. Case 11. Roentgenogram taken nine days later reveals an air pocket in the upper part of the globular shadow with a horizontal fluid level separating the clear zone from the lower dense area. On the preceding day the infant coughed up some thick brown fluid. The cyst had apparently ruptured into a neighboring bronchiole and air has displaced part of its fluid content.

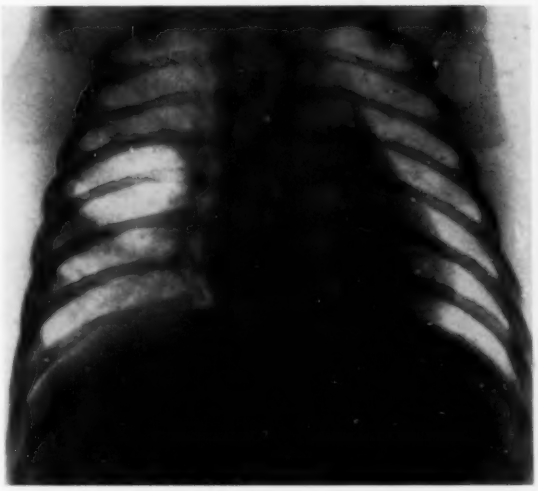

Fig. 8. Case 11. Roentgenogram taken two weeks later shows the fluid content of the cyst entirely replaced by air. The moderately thin wall of the cyst can be demonstrated. Because the lesion is no larger at this time than originally, it indicates the presence of a free channel between the cystic cavity and the bronchus with no obstruction to the ingress and egress of air. Therefore, the lesion is now classified as a non-expansile air cyst.

Two weeks later, the infant was again observed and showed a gain of 2 pounds 3 ounces. During this time there were no symptoms. Roentgenographic study (Fig. 8) portrayed a circular shadow in the right lung corresponding to the globular opacity originally observed. However, the central density was entirely gone and replaced by a transparent zone. Apparently, the retained fluid had been entirely evacuated and replaced by air disclosing the moderately thin walls of the cavity.

When observed again, two months later, the encapsulated air had disappeared and the walls were absorbed. The child continued to gain in

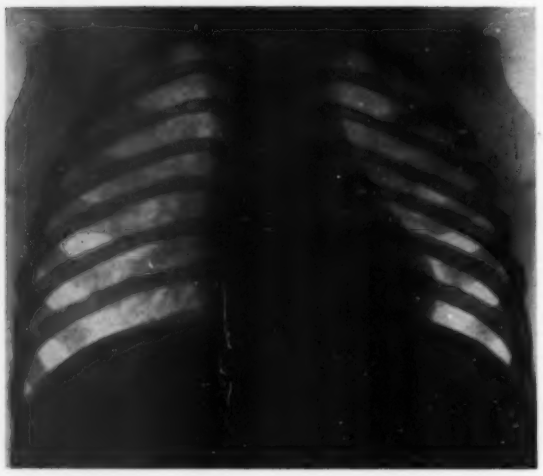

FIG. 9. Case II. Roentgenogram taken eleven months later presents a clear pulmonary field on the right. The air cyst has entirely resolved leaving normal lung structure in its place.

weight, and appeared well nourished and healthy in every respect. Repeated examinations (Fig. 9) failed to disclose any abnormal or pathological findings. Observed for almost two years, the child remains well and symptom-free.

Comment. A solitary non-expansile fluid cyst of the right lung is presented in an infant five weeks old, with no symptoms referable to the respiratory tract. During an attack of vigorous coughing, the baby coughed up some thick tenacious fluid. When roentgenographed on the following day, the cystic cavity showed a fluid level above which was a pocket of air, suggesting that the cyst had ruptured into an adjacent bronchiole. Finally, the cyst, entirely replaced by air, collapsed and the lesion spontaneously disappeared.

CASE III. H. K., a male infant, was a first child of apparently healthy parents. Delivery had been instrumental; no history of difficult resuscitation or of dyspnea and cyanosis could be elicited. The child was examined at the age of one week because of vomiting and inability to gain weight. The infant appeared normal except for the chest findings. Respiratory embarrassment and cyanosis were absent. The entire right side of the chest was tympanitic, with absent voice and breath sounds. The heart was displaced to the left, the right border percussing at the midsternal line.

Roentgen examination (Fig. 10) showed the entire right lung replaced by air; the heart and mediastinum pushed to the left. The costophrenic sinus appeared obliterated; the pulmonary apex somewhat hazy. No stump of a collapsed lung was observed. The air encroached upon the mediastinal region and also upon the diaphragmatic cusp. An opaque meal ruled out a diaphragmatic hernia and eventration.

The child was again studied roentgenologically at the age of two years. He had had several attacks of bronchitis in the left lung without undue complications or consequences. At no time had he suffered from attacks of dyspnea and cyanosis. He appeared physically small for his age and showed a bulge of the right thoracic region. The tuberculin reaction had been negative up to 5 mg. Physical signs were unchanged. Roentgen study (Fig. 11) showed the absence of lung markings in the right chest from apex to base. The costophrenic sulcus was obliterated. The air overlapped the mediastinum and the right cardiac border. In this region a moderately dense wall was portrayed limiting the large air pocket. The right leaf of the dia-

FIG. 10. Case III. Male, aged one week. There is evidence of a marked transparency in the right lung field extending to the apex and costophrenic sinus as well as encroaching upon the mediastinum. The heart is definitely displaced to the left and the radiotransparency appears to extend beyond the diaphragmatic cusp. No lung markings are visible on the right, although in the apex a few linear bands are noted. The right costophrenic sulcus is in most part obliterated.

phragm was flattened and the heart displaced well to the opposite side. At the right base and adjacent to the midline, several fine strands or bands were noted appearing in sweeping curves.

Comment. The diagnosis of balloon or expansile air cyst is justified in this case from the roentgen study which shows a persistence of the large air pocket, the presence of the cystic wall, the obliteration of the costophrenic sulcus and the haziness at the pulmonic apex (due to the airless lung compressed in all directions by the expanded cyst), the presence of fine sweeping or curving bands or trabeculations traversing the cystic space, and the absence of the stump of a collapsed lung at the root.

At this writing the child is six years old, and is apparently without noticeable symptoms. Although the roentgenograms of his present status are not in my possession, I am given to understand that the lesion remains practically unchanged.

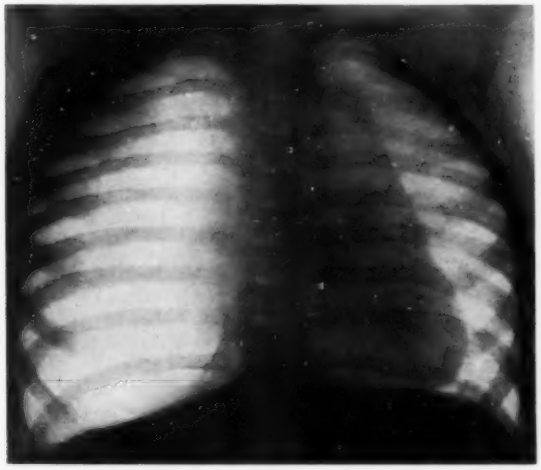

Fig. 11. Case III. Male, aged two. The entire right lung shows a complete radiotransparency extending from apex to base indicative of an expanding lung cyst. The costophrenic sinus is obliterated and the apex is slightly cloudy, due to the huge cyst compressing the lung tissue in all directions. The mesial wall of the cyst can be demonstrated, encroaching upon the mediastinum and heart, which are decidedly displaced to the left. At the right base adjacent to the mediastinum one notes several thin slightly curved linear bands or trabeculations. The right diaphragmatic dome is flattened and depressed. The left lung is clear.

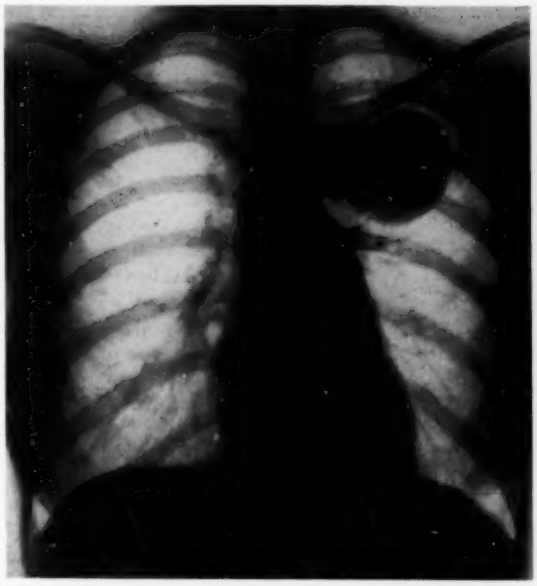

Fig. 12. Case IV. Female, aged seventeen. A dense globular mass with sharp borders is present in the upper left lung just beneath the clavicle. This shadow remained unchanged over a period of six months. The roentgen interpretation is a congenital solitary fluid cyst.

Case IV. L. M. (a patient of Drs. Meyer Rabinowitz and Milton G. Wasch), female, aged seventeen, unmarried, complained of a lump in the epigastrium after meals. This symptom, associated with anorexia and slight weakness, was irregularly present and dated back over a period of nine months. There had been no previous serious illnesses. She also gave a history of upper abdominal gaseous distention and a distressed feeling "around the heart." Relief was afforded to a great extent by belching which was often induced by the use of effervescent salts. There was no nausea or vomiting; no pains in the abdomen or chest. The bowels were costive and relieved by mineral oil. She had gained a few pounds in the past year. Urinary and menstrual disturbances were absent. Except for the slight dyspnea which the patient attributed to the epigastric distention, there were no symptoms referable to the respiratory system.

Physical examination revealed a healthy appearing young female adult, with dullness on percussion over the left infraclavicular space. A short systolic murmur was present over the pulmonic area. Urinalysis and blood study were negative; no eosinophilia was present. Roentgen examination (Fig. 12) showed a large

densely opaque globular mass, the size of a goose egg, lying in the upper portion of the left lung field. The patient was given four high voltage roentgen treatments to the upper left chest with no apparent change in the size or density of the mass.

The patient was observed for a period of six months, after which she was lost sight of and could not be traced. During this time she had gained a few pounds in weight and remained well except for her original complaints which persisted unchanged. There was never any cough or expectoration. The follow-up roentgenograms revealed the same globular shadow in the upper left lung as on the original studies, with no alteration in size or density.

Comment. From the above history and course, and from the absence of physical findings other than a dull percussion note in the left infraclavicular space, one is justified in the diagnosis of a congenital solitary fluid cyst from the roentgenographic findings.

SUMMARY

The literature of congenital cystic disease of the lung is reviewed and 232 cases are analyzed. A clinicopathological study has been made of the reported cases, describing the various types, their symptomatology, and roentgen appearance. The differential diagnosis, prognosis, and treatment are next discussed. Four new cases are presented and described in detail. No longer a pathologic curiosity accidentally found on the autopsy table, congenital cystic disease of the lung is an established clinical entity, readily recognized during life. In infants and young children, the lesion is attended with grave prognostic dangers. In older patients, the recent advances of thoracic surgery offer hope that may some day embrace patients of all ages who are afflicted with the various types of congenital pulmonary cystic malformations.

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THE ACCESSORY PULMONARY LOBE OF THE AZYGOS VEIN*

AN ANATOMICAL REPORT OF THREE CASES

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PULMONARY variations which owe their occurrence to unusual branching of the embryonic bronchial buds are recognized as common; less frequent are those variations which depend upon external factors. The type within this latter group which has aroused greatest interest is that in which a small accessory lobe is dependent upon an aberrant position of the loop of the azygos vein (Fig. 1). In such cases the venous loop, instead of remaining in contact with the vertebral column as it arches over the root of the lung, follows a longer course swinging away from the vertebrae and enclosing an accessory medial lobe as it does so. The anomalous vein, being thus removed in its course by a distance of several centimeters from the mediastinum, is supported by a mesentery-like fold of the parietal pleura sent inferiorly from the summit of the pleural cavity. This two-layered pleural reflection, with the contained vein in its free lower margin, occupies the fissure between the upper lobe and its accessory portion, and thus divides the superior fourth of the pleural cavity into two compartments which communicate below.

Our laboratories have, during the current school year, yielded 3 such specimens of accessory lobe in a total of 68 cadavers dissected.† The interest displayed by the members of our Department of Radiology in this variation has made it seem desirable to report the distinctive anatomical features of such cases.

†The senior author observed no other cases in the dissecting laboratories during the five years in which he has systematically tabulated all striking anomalies—i.e., in a total of 350 specimens. Dr. W. F. Windle assures him that none occurred during four preceding years (280 specimens); the concentration of cases of this infrequent pulmonary anomaly is in itself interesting.

Wessler and Jaches[11] first reported the appearance of the anomalous vessel on roentgen films, while Bendick and Wessler[2] established the connection between the typical shadow and the anomalous vessel and lobe observed at autopsy. Since then roentgenological reports have become numerous. Anatomical descriptions of the azygos lobe and fissure were available earlier; 22 were conveniently tabulated by Stibbe in 1919, and hence need not be reviewed here. Since Stibbe's summary, anatomical accounts of at least 12 cases have been presented: 2 by Cairney,[3] 1 by Rosenberger,[9] 2 by Hjelm and Hultén,[4] 2 by Bendick and Wessler,[2] and 1 each by Leeser,[7] Kayne,[6] Nelson and Simon,[8]* Jullien, Ecot and Mollard,[5] and Atkin.[1]

REPORT OF CASES

CASE 1. White male, aged sixty-five; height 5 ft. 4 in.; weight about 140 lb.†

(a) *Azygos Vein.* The vein courses superiorly upon the anterior surfaces of the thoracic vertebra as high as the 8th, receiving intercostal tributaries en route (Fig. 2); it lies dorsal to the esophagus and to the right of the midline. From this point it ascends to the level of the 5th costovertebral articulation, gradually deviating lateralward and dorsalward; instead of arching forward over the root of the lung, it turns outward at nearly a right angle to pursue its course through the fissure in the lung (Fig. 1). The horizontal venous loop is thus formed, which, passing ventrally—first laterally, then medially—terminates in the superior vena cava at a point just inferior to the junction of the right and left innominate veins (Fig. 2). The superior intercostal vein descends

* Who also report data on incidence in roentgenograms: 4 in 3,000 at the Royal Chest Hospital of Liverpool; 6 in 6,000 at the City of London Hospital.

† All illustrations were prepared from Case 1.

* Contribution No. 219 from the Anatomical Laboratory, Northwestern University Medical School.

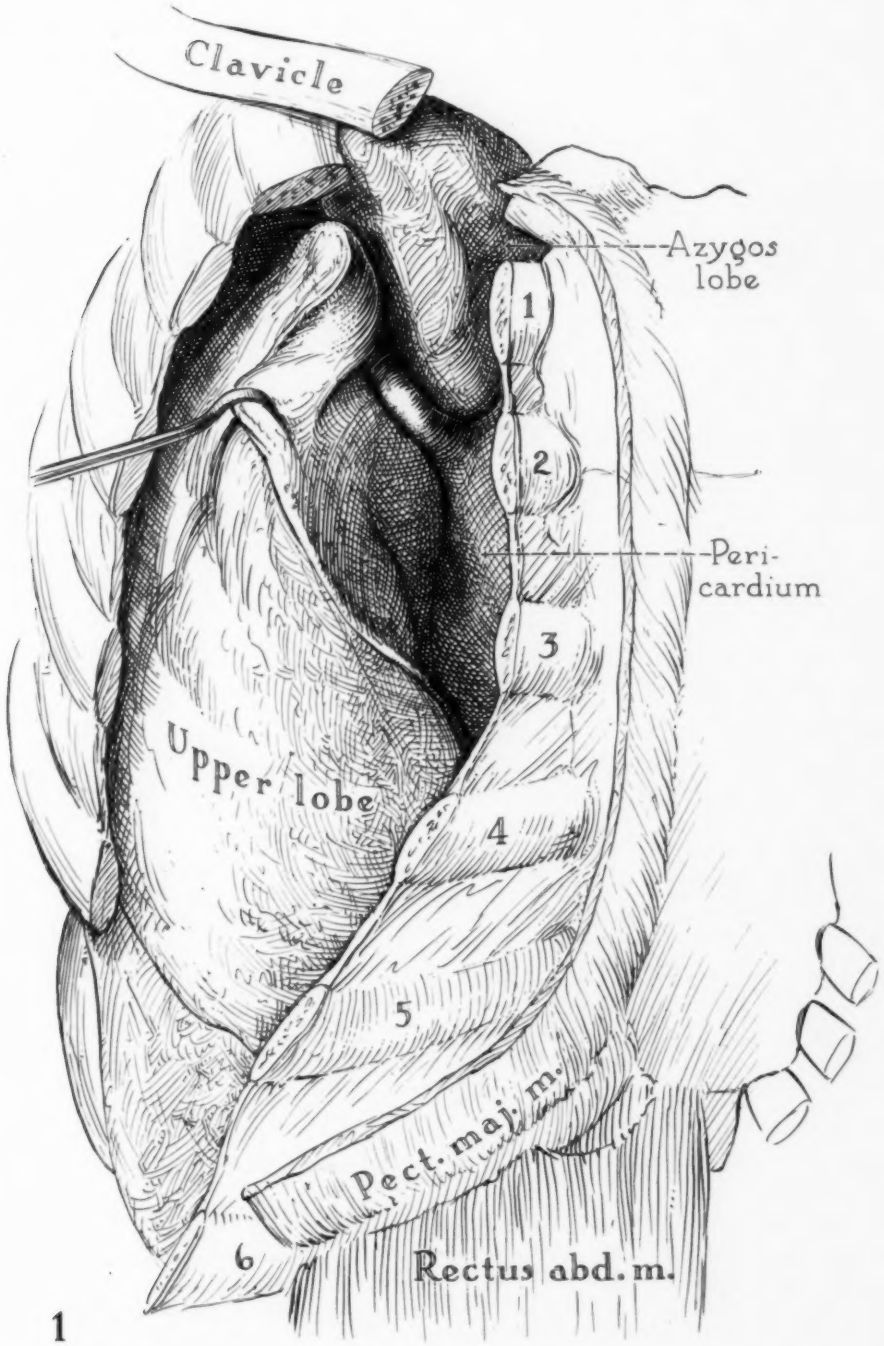


Fig. 1. Contents of the right pleural cavity as seen after the partial removal of the clavicle, pectoral musculature, thoracic wall, and parietal pleura. The upper lobe of the right lung is retracted to expose the accessory pulmonary lobe and the anomalous azygos vein. The mesoazygos has been removed; ¾ natural size.

along the bodies of the upper thoracic vertebrae and joins the azygos as the latter enters the pulmonary fissure.

(b) *Pleural Reflection.* Between the lateral portion of the vertebra behind and the superior vena cava in front the vein lies in a pleural reflection, disposed so that its outer surface is convex (Fig. 3). The line of reflection of the parietal pleura begins inferolaterally on the right side of the body of the 5th thoracic vertebra, near the superior border and proceeds laterally and superiorly across the fourth, third, and second ribs; attaining the first rib it follows the latter's superior border in a forward direction, becoming continuous with the mediastinal pleura, along which it descends to the

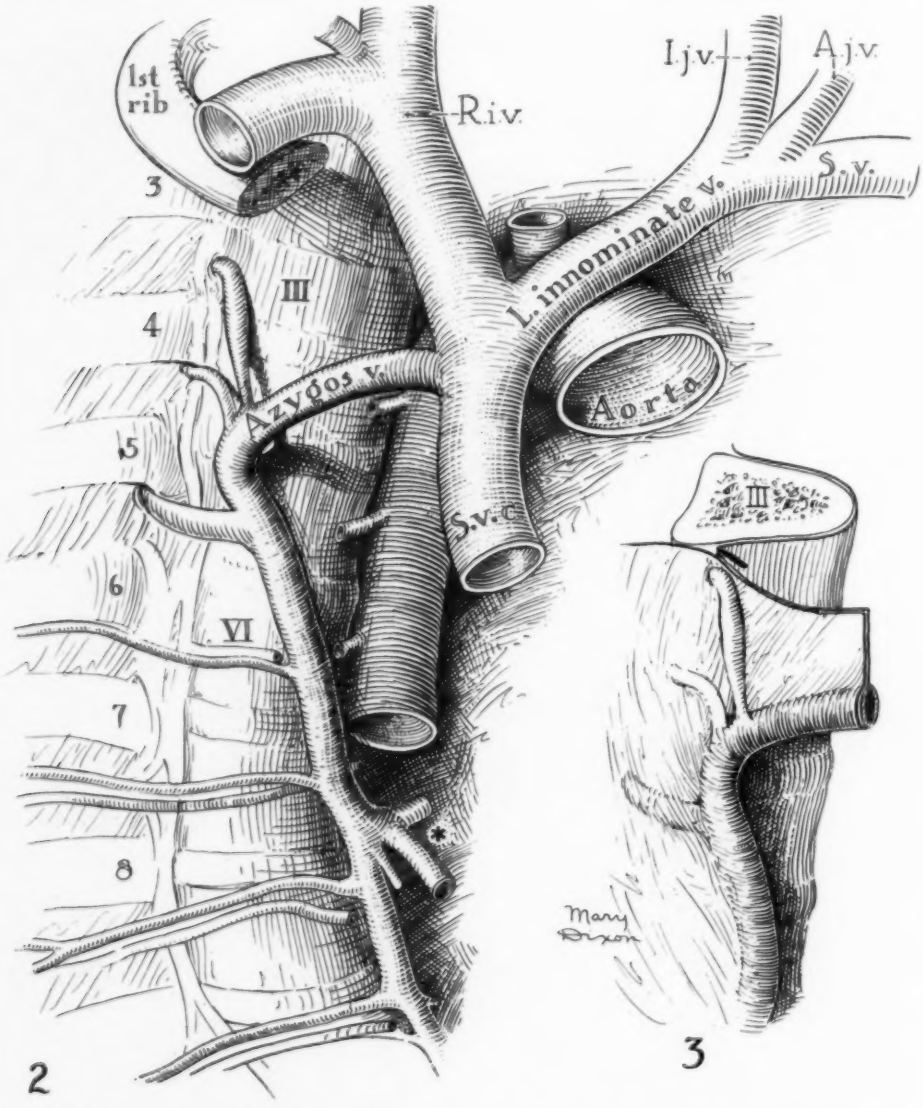
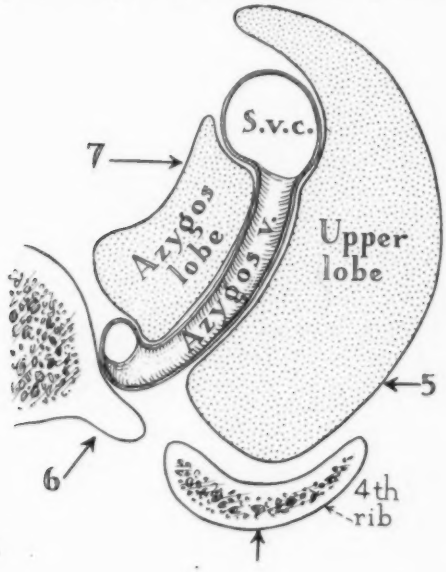


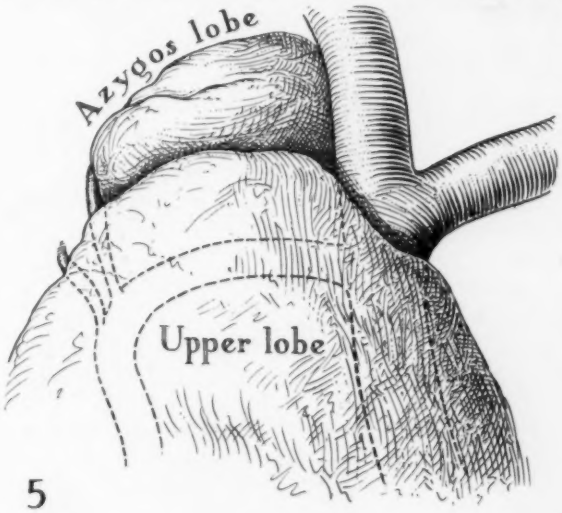
FIG. 2. Structures on the dorsal thoracic wall, after the removal of the pericardium, heart, lungs, and parietal pleura; seen in ventrolateral view. Showing the azygos veins, the associated great vessels, and (at asterisk) the transverse connection between the azygos and hemiazygos vein. Abbreviations: *R.i.v.*, *I.j.v.*, *A.j.v.*, *S.v.*, *S.v.c.*, right innominate, internal jugular, anterior jugular, subclavian veins, and superior vena cava, respectively. $\times\frac{3}{4}$.

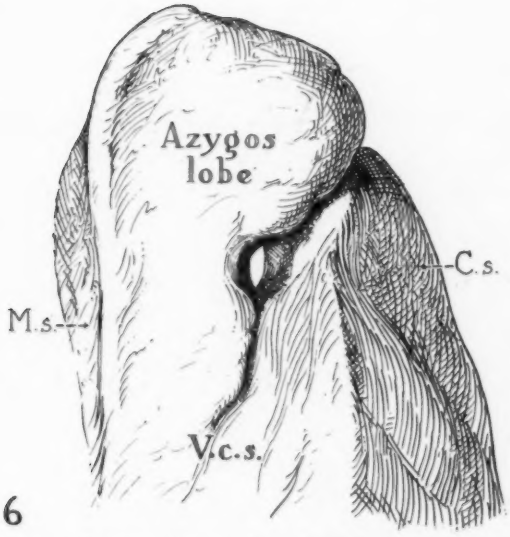
FIG. 3. The anomalous azygos vein with part of its reflection of the parietal pleura (semidiagrammatic). $\times\frac{3}{4}$.

level of the junction of the azygos vein with the superior vena cava.

(c) *Accessory Lobe.* The additional pulmonary lobe is situated at the apex of the right lung (Figs. 4 to 7) and appears as an appendage of that part. It is broadest at the midportion,







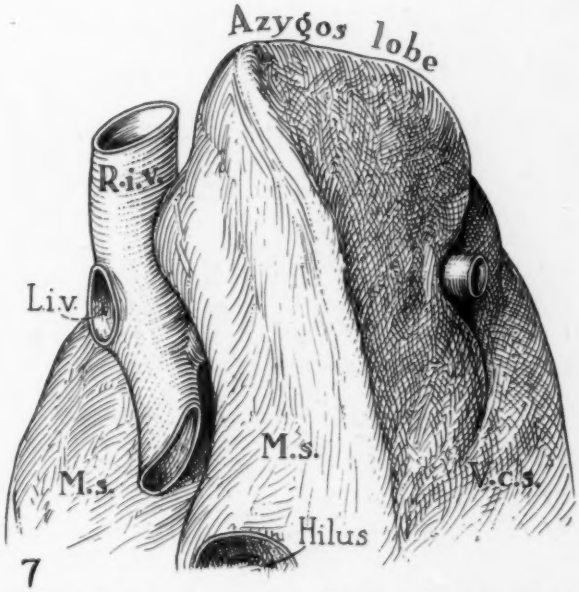


Fig. 4. Transverse section through the right lung and related structures at the level of the loop of the anomalous azygos lobe (thoracic level of fourth vertebra). Arrows with numerals indicate the direction of view in the figures with corresponding numbers. Unnumbered arrow marks the angle of the rib. Semidiagrammatic. $\times\frac{3}{4}$.

Fig. 5. Superior portion of right lung, in lateral or costal view, showing the pulmonary relations of the anomalous azygos vein and its connections (cf. Fig. 2). Direction of view indicated at 5 in Figure 4. $\times\frac{3}{4}$.

Fig. 6. Same specimen in dorsomedial view, showing the upper and the azygos lobes and the sulcus from which the anomalous azygos vein has been removed; shown also are the vertebrocostal surface of the lobes (*V.c.s.*), with adjacent portions of the mediastinal (*M.s.*) and costal surfaces (*C.s.*); the prominent margin separating the latter two is accommodated to the groove formed by the angles of the ribs (see unnumbered arrow in Fig. 4). Direction of view is indicated at 6 in Figure 4.

Fig. 7. Same specimen in medial or mediastinal view, showing the mediastinal and vertebrocostal surfaces. Costal surface out of view to right. Direction of view indicated at 7 in Figure 4. $\times\frac{3}{4}$.

tapering somewhat toward the attached portion and toward the free tip. It projects 2.2 cm. above the upper lobe.* The sulcus is 3.8 cm. deep, the lobe itself is 2.5 cm. wide (across the base, measured along the medial surface), and 4 cm. thick (from medial surface through the lobe to the sulcus).

Case II. White male, aged fifty-five; height 5 ft. 7 in.; weight 145 lb.

(a) *Azygos Vein.* The vein pursues an upward course, as in the preceding case, to the lateral surface of the body of the 5th thoracic vertebra; thence forward, at a right angle to form a loop through the pulmonary fissure. The horizontal plane of the loop coincides with that of the intervertebral disc between the fourth and fifth vertebrae. Termination as in Case I.

(b) *Pleural Reflection.* The line of reflection of the parietal pleura starts with the point of departure of the vein from the 5th thoracic vertebra; proceeding superiorly it gradually assumes a more lateral position, reaching the first rib at its angle. Then it passes medially and ventrally across the first rib, at the superior border of which it reaches the mediastinal pleura; therefrom the line of reflection is carried inferiorly to the caval extremity of the azygos vein.

(c) *Accessory Lobe.* The anomalous lobe projects 4 cm. above the upper lobe; its sulcus is 4 cm. deep; the lobe is 2 cm. wide and 3 cm. thick. The diaphragmatic and costal surfaces of the lower lobe in this specimen were adherent; otherwise this lung, and the other two specimens, displayed no gross pathology.

Case III. White male, aged forty-five; height 5 ft. 8 in.; weight 140 lb.

(a) *Azygos Vein.* In general, its course is similar to those just described. At the lateral surface of 4th thoracic vertebra, the loop extends ventralward through its fissure to join the inferior vena cava just below the point of confluence of the innominate veins.

The anomalous azygos vein is likely to be longer than the corresponding vessel of normal cases; thus in measurements of 30 consecutive normal specimens, the lengths of the azygos loops* were as follows: the shortest was 3.2 cm. in length, 21 were between 3.5 and 4.5 cm., 6 between 4.6 and 5.0 cm., 1 of 5.5 cm., the longest 6.2 cm. The anomalous azygos loop in Case I and Case II was 6.3 cm., i.e., approximately twice as long as the shortest example among the normal specimens; in this case (III), however, it was but 5.5 cm. long.

(b) *Pleural Reflection.* Removed before observation.

(c) *Accessory Lobe.* The extra lobe is less prominent than in the two other cases, projecting but 1 cm. above the level of the upper lobe; the fissure, however, is deep, measuring 4 cm.; the lobe is 1.5 cm. wide, and 2.5 cm. thick.

* These measurements were made on the fixed, excised specimen; they are therefore smaller than in life; the lung, however, was moist, so that any further change, from desiccation, was prevented.

* Measured from dorsal beginning of horizontal course to caval termination.

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ATYPICAL ROENTGEN APPEARANCE OF PULMONARY INFARCTION IN PATIENTS WITH HEART FAILURE*

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AT TIMES the roentgen appearance of pulmonary infarcts is deceptive. In one of the following cases the roentgen appearance suggested pulmonary neoplasm, in the other pulmonary tuberculosis.

CASE REPORTS

CASE 1 (No. 347007). I. M., aged seventy-two, housewife, was admitted to the Mount Sinai Hospital on December 21, 1932. Two years previously she had, for a period of three weeks, "gallbladder" disease with jaundice. For one year she had noted precordial pain on exertion, radiating to the arms, relieved by rest and followed by belching. Three weeks prior to admission she developed sudden pallor and coldness with severe palpitation but no pain or dyspnea. For three days immediately preceding admission the precordial pressing pain became more severe, extending into the right arm, worse at night. Dyspnea, orthopnea with wheezing respiration, and cough set in. At the time of admission she was pale, emaciated, dyspneic and orthopneic. There was slight cyanosis of the lips and finger tips. Numerous rhonchi were heard throughout the lungs; also many crackling râles posteriorly from the scapulae to the bases. The heart was not enlarged to percussion; no murmurs were heard. The second aortic sound was louder than the second pulmonic; premature contractions were present. Blood pressure was 160/100. The liver was tender and extended three fingers' breadth below the costal margin. Venous pressure was 17 cm. The hemoglobin was 90 per cent; the red blood cells 5,200,000 per cubic millimeter; white blood cells 3,800 with 71 per cent polymorphonuclear leukocytes. The urine had a specific gravity ranging from 1.020 to 1.028, two plus albumin, no sugar, and an occasional leukocyte microscopically. The blood urea nitrogen was 10 mg. per 100 c.c. of blood; blood sugar 110 mg. per 100 c.c. of blood. The Wassermann reaction was negative. The electrocardiogram showed partial inversion of T-1, abnormal R-T transition in leads I and III.

On the night of admission she vomited 4 ounces of undigested food and shortly afterward was found in extreme dyspnea, relieved by 1 gr. of codeine given hypodermically. The temperature rose on the third day after admission to 102° F., and a cough productive of thick brown sputum appeared. The right upper quadrant of the abdomen was tender. The blood pressure had fallen to 110/80 on the seventh day after admission; the temperature

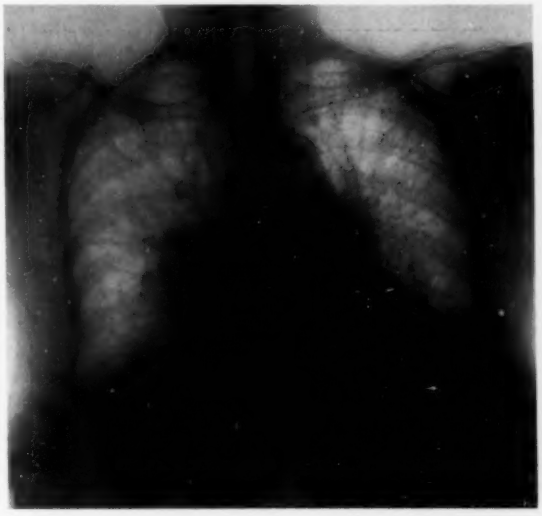

FIG. 1. Case 1.

slowly mounted; Cheyne-Stokes respiration set in and the patient died on the eighth day after admission.

The roentgen examination of the chest (Fig. 1), taken two days after admission, showed a dense shadow at the root of the right lung, suggesting involvement of the lymph nodes in this region, which aroused the suspicion of pulmonary neoplasm. Hypertrophy with moderate dilatation of the left ventricle was also noted.

Autopsy, performed four hours after death by Drs. King and Hitzig, showed old occlusions of the proximal portion of the left coronary artery and of the distal portion of the right coronary artery; marked coronary sclerosis

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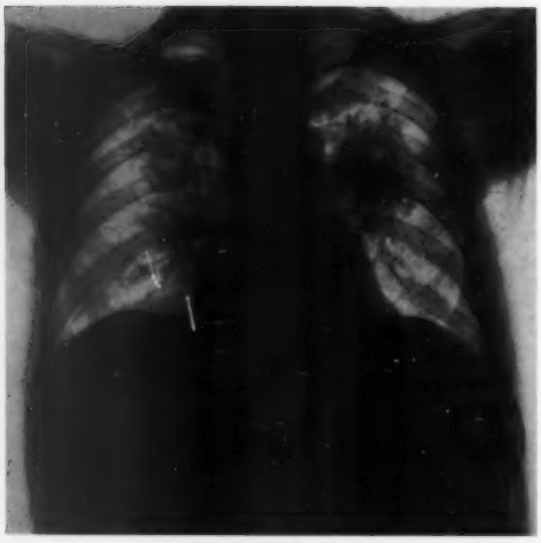

Fig. 2. Case II.

with narrowing; acute myomalacia of the posterior wall of the left ventricle with aneurysmal formation; acute myomalacia of the apical portion of the anterior wall of the left ventricle. There were intraventricular ante-mortem thrombi at the apical portion of the left and right ventricles. Dilatation of the right and left ventricle and left auricle was noted as was atherosclerosis of the aorta. Passive congestion of the lungs and liver was present. There was hydrops of the gallbladder, chronic cholecystitis and cholelithiasis. Multiple infarcts of both lower lobes were evident; the surfaces of these lobes contained a number of firm, airless, deep bluish-red areas; a very large area of pulmonary infarction, 5 by 7 cm. in size, occupied the posterior aspect of the right lower lobe near the vertebral border. The pulmonary arteries supplying the red areas contained emboli, some of which were slightly adherent to the walls of the vessels. The pulmonary vessels otherwise showed a marked degree of atherosclerosis.

Case II (No. 378345). E. S., male, aged seventy-two, an unmarried peddler, was admitted to the Out-Patient Department of the Mount Sinai Hospital on January 11, 1935. He had haphazardly cared for his diabetes for fourteen years; no insulin was ever taken. He noted, during the past few years, increasing dyspnea on exertion, palpitation on ascending stairs, compelling him to stop, and a constriction around the lower part of the chest produced by exertion, for which he stopped his activity for several minutes to catch his breath. For three months before his first observation at the clinic he had a hacking cough productive of whitish sputum; there was no blood-streaking or hemoptysis. A roentgenogram of the chest (Fig. 2), taken on January 14, 1935, showed infiltrations extending from both roots to the periphery of both upper lobes, considered as probably inflammatory. On March 3, 1935, roentgen examination of the chest showed partial resolution of the infiltration with a pleural effusion and thickened pleura at the right base; there was a possible infiltration in the right lower lobe. He was hospitalized on April 2, 1935. On admission he was rather cachectic and pale, not cyanotic or dyspneic. Over the lower half of the right lower lobe, and extending into the axilla, there were flatness, diminished breath sounds and fremitus; scattered râles were heard over both bases and axillae. The heart was moderately enlarged to percussion; heart sounds were of poor quality. The second pulmonic sound was louder than the second aortic; frequent premature contractions were present. A small hard nodule was palpated in the lowermost part of the prostate gland. Blood pressure was 140/90. The hemoglobin was 84 per cent. The white blood cells numbered 5,700 of which 76 per cent were polymorphonuclear leukocytes. The urine had a specific gravity of 1.012 to 1.024, no albumin, no sugar, an occasional leukocyte microscopically. Blood urea nitrogen was 21 mg. per 100 c.c. of blood; blood sugar 230 mg. per 100 c.c. of blood. The carbon dioxide combining power of the blood plasma was 70 volumes per cent. The icteric index was 7. The Wassermann reaction was negative. The electrocardiogram showed an occasional auricular extrasystole; QRS complex was notched and slurred, and of low amplitude in the standard leads, of high amplitude in lead IV; T-1 was inverted, T-2 isoelectric, T-4 diphasic. The sputum was repeatedly negative for tubercle bacilli. The sedimentation rate of the red blood cells was fifty minutes. The right chest was tapped, 1 liter of deep amber fluid was removed; specific gravity 1.008; 108 cells per c.c., all lymphocytes; no tumor cells were found on stained section of the centrifuged sediment. Two cubic centimeters of mercupurin was given by muscle three times during hospitalization, with a progressive diuresis and consequent loss of 20 pounds during his three weeks' stay. On April

18, 1935, the electrocardiogram showed increased voltage.

Roentgen examination of the chest on April 6, 1935, four days after admission, showed an effusion occupying the lower third of the right pleural cavity. The lesions in the upper portion of the lungs showed further resolution. On April 20, 1935, eighteen days after admission, at the time when most of the edema was gone, the roentgenogram (Fig. 3) showed no evidence of pulmonary congestion; the shadow in the left lobe had completely disappeared.

Fig. 3. Case 11.

DISCUSSION

In a patient with heart disease an intercurrent pulmonary lesion should arouse the suspicion that it may be the result of infarction.

In recent years routine roentgenograms, and especially the use of the bedside roentgen technique, have disclosed an unsuspected frequency of pulmonary infarcts which were clinically unrecognized. The progress and involution of infarctive lesions have been carefully studied by the roentgen method. Yet many such lesions continue to be missed clinically, often to be first discovered at autopsy, even when roentgenograms, taken during life, showed no lesions. In some cases the silent character of the process accounts for the failure of recognition; in others the suggestive, at times classical, symptoms and signs are not properly interpreted because the possibility of infarct is not entertained. In still others (the theme of this report) the atypical location or character of the lesion, or both, are responsible for incorrect interpretation of the films and consequently of the clinical symptomatology.

Infarcts are generally described as peripherally placed, roughly triangular shadows, the base at the thoracic wall or diaphragm, the apex pointing toward the hilus. The postoperative embolic infarct, according to Wharton and Pierson,[12] shows universal pleural involvement, indicating its anatomically peripheral situation. Further, the great majority of infarcts occur in the right lung, especially at the base of the right lung, 84 and 72 per cent respectively, in a mixed group of postoperative patients and others with decompensated heart disease, reported by Kirklin and Faust.[5] In Kohlmann's experience,[6] in a group composed mostly of patients with decompensated heart disease, the right side, especially the right lower lobe, was the usual site of the infarct. He also pointed out a predilection for the region around the interlobar fissure between the right upper and middle lobes. While an infarct may be anatomically peripheral, its base may lie on the anterior or posterior aspect of the lung. Therefore, besides the conventional anteroposterior position, a lateral view is necessary to make the anteroposterior localization. Besides the triangular shaped shadow with centrally directed apex, Rieder and Rosenthal[9] describe the round or egg-shaped shadow, the base lying anteriorly or posteriorly, the apex directed sagittally.

Infarcts, atypical in location and character, are found mainly in congested lungs of patients with heart failure. Rarely atypically placed shadows occur in the postoperative embolic group. Boehm and Kühne[3] cite the case of a forty-one year old female who, eight days after hysterectomy for fibroids, suddenly, while on a bed pan, developed cyanosis and a rapid pulse with-

out pain or hemoptysis. Three weeks later a roentgenogram showed a roughly oval shadow in the right middle lung field, largest at the hilus and tapering off gradually at the periphery. Among the various types of atypical shadows cast by infarcts is the one cited by Laubry, Soulié and Poumeau-Delille.[7] The patient had pulmonic stenosis with right heart failure and hemoptysis. The roentgenogram showed clouding of the lower two-thirds of the left lung field and almost complete clouding of the right, sparing only the extreme apex and base. A similar, though less extensive shadow, proved at autopsy to be caused by fresh hemorrhagic infarcts, is reported by Pritchard and Mortensen[8] in a patient with heart failure.

Of greatest importance, in the consideration of this atypical group, is the presence or absence of pulmonary congestion, usually induced by cardiac failure. Infarcts which occur in passively congested lungs, often referred to as stasis infarcts, are poorly visualized because the congested lung is of about the same density as the infarcted area (Assmann,[2] and Rieder and Rosenthal[9]). Laubry et al., in calling attention to the deceptive roentgen appearance of the lungs in patients with heart disease, cite a case in which the roentgenogram, taken in the anteroposterior position, showed a triangular shadow with its base at the right hilus and a rounded shadow bordering the left hilus. At autopsy there was intense congestion of the lungs from apex to base, giving them the appearance of carnification; no infarcts were present. This same anatomic, not to say roentgenologic, illusion was strikingly illustrated recently in the case of a fifty-seven year old male with multiple myocardial infarctions, several of which were fresh, who at autopsy showed extreme pulmonary congestion, giving the appearance of infarcts, involving both lungs entirely, save for a shell of uncongested emphysematous lung of about 2 cm. in diameter. No infarcts were found in these large central areas. Small insignificant peripheral (embolic) infarcts were present.

According to Kohlmann the congestion infarct casts a round shadow which is more medially located and less sharply demarcated than the embolic type. However, the peripherally situated, wedge-shaped embolic infarct does occur in the congested lungs of cardiac decompensation when there are mural thrombi in the right chambers of the heart as in the case cited above.

Cases like ours have been reported.

Kohlmann cites the case of a fifty-four year old woman with mitral stenosis and heart failure and hemoptysis. The roentgenogram showed a fairly dense rounded shadow in the right lower lobe bordering the heart (very similar to Fig. 1). Autopsy, two months later, showed an organized infarct of that lobe. Coste and Sergent[4] have reported pulmonary infarcts simulating pulmonary neoplasms. In a recent paper on the various aspects of pulmonary infarcts, Antonelli[1] reviews a number of atypical cases of pulmonary infarcts reported by several French observers and points out the simulation of cysts and neoplasms by such atypical infarct shadows.

The interpretation of the shadow in Case II can be questioned. It may be considered pulmonary congestion, as in the case cited above by Laubry et al. The shadow in the right lung field suggests congestion more than infarct. The shadow on the left is more circumscribed and is separated from the hilus by a thin zone of less involved lung. The lesions, especially that on the right, strikingly resemble early tuberculous infiltrations. The similarity between tuberculosis and congestion of the lungs is pointed out by Wessler and Jaches;[11] in some cases differentiation is difficult. The disappearance of the shadows in both lung fields during restoration of cardiac compensation, together with the repeatedly negative sputum examinations, seems to rule out an involuted early tuberculosis. The lesion on the left resembles the exudative

type of early tuberculosis which is prone to caseation and cavitation and not to so speedy an involution with absence of residual fibrosis or calcification. According to Wessler and Jaches, it is only in the smallest incipient tuberculous lesions that complete disappearance of shadows is seen. In considering this question of time of involution, it is interesting to note that Kohlmann favored the diagnosis of tuberculosis or bronchopneumonia rather than infarct in an undiagnosed infiltration in the right upper lobe bordering the right middle lobe, because the shadow disappeared in two months. Boehm and Kühne, however, report the practically complete disappearance of a shadow in two months, in the case of a postoperative embolization.

The persistence of roentgen shadows months after the development of infarcts has been repeatedly pointed out (Wharton and Pierson). Kohlmann cites one case of a twenty-nine year old male with mitral stenosis, in whom a peripheral triangular shadow persisted for a period of five months, with only the slightest changes in appearance. Unverzagt[10] cites 3 cases of pulmonary embolization with infarction occurring shortly after lower extremity thrombophlebitis. Shadows interpreted as organized infarcts were found years afterward, notably residual thickened pleura with adhesions accompanying the shadows. In one case the period was twenty-seven years.

SUMMARY

1. Two cases with unusual roentgen pictures of pulmonary infarcts are described. In both the infarction occurred complicating heart failure with pulmonary congestion secondary to coronary arterial sclerosis.

2. The importance of pulmonary congestion as a factor in the atypical situation and roentgen appearance of pulmonary infarcts is stressed.

3. The persistence of residua of infarct shadows over months and years is pointed out.

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ROENTGEN KYMOGRAPHY OF THE HEART AND GREAT VESSELS*

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THE principle of roentgen kymography was first employed by Sabat in 1911 and a year later by Gött and Rosenthal. The procedure received attention by only a few observers until Stumpf in 1928 improved the apparatus by employing a grid with multiple parallel slits instead of one or the few used in the earlier experiments. The advances that had taken place in roentgenographic equipment in the interim was also a contributing factor in the better results and increased popularity of the improved kymograph.

Sundberg in Sweden, and Delherm, Thoyer-Rozat and Fischgold in France, by using wider slit spacing and increasing the rate of either film or grid movement, produced kymograms with a spread of wave form so that even minute changes excited by closure of the heart valves became visible.

Later Cignolini in Italy, by using a stationary grid with many short slits, with adjustable spacing, and increased rate of film travel, was able to record as wave forms the lateral movement of several preselected points on the heart silhouette with even greater spreading.

Although commonly used in Europe, kymography, with few exceptions, appears to have been ignored in the United States. Crane in 1916 was the first in this country to use the slit principle in the study of the heart. His apparatus, designed and built by himself, consisted of five adjustable vertical lead panels with slits 2 cm. wide. The film was moved at a uniform speed behind this stationary grid. Crane also fully explained the principle of kymography and pointed out its practical application. The problem appears to have received no further attention in this country until Hirsch, in his excellent articles, made valuable contributions to the interpretation and simultaneously recorded heart sounds and kymograms as well as electrocardiograms and kymograms.

Our kymograph is of simple construction and was made from a discarded Potter-Bucky diaphragm. In place of the standard roentgenographic grid, we have constructed two interchangeable kymographic grids. One modeled after that of Stumpf has 0.5 mm. slits spaced 12 mm. apart and the second, modeled after that of Sundberg, has slits of the same width spaced 30 mm. apart. The Stumpf grid will record lateral displacement of a number of points on the heart silhouette closely recorded in 12 mm. panels, whereas the Sundberg grid, for equal periods of exposure, will record the same number of waves spread out over panels 30 mm. wide.

We have used the kymograph for the past year and a half with a great deal of enjoyment and satisfaction. While we readily admit that up to the present time our opinions and conclusions have been guided by clinical findings, we have found the kymograph to be of real aid in certain instances and believe that it has a definite place in the roentgenographic study of the heart and great vessels.

It is in the hope of stimulating more interest in the use of the kymograph in this country that we wish to report the following cases.

CASE REPORTS

CASE 1. C. E., female, aged forty-nine. Patient came to the hospital because of recurrent attacks of asthma.

Physical examination shows bilateral emphysema. Heart is small. No murmurs. Blood pressure: 105 systolic, 65 diastolic. Wassermann and Kahn tests negative. Kymogram made with a three second run of the Stumpf grid

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shows a small normal heart with a pulse rate of 90. The left border is well outlined and the aortic, pulmonic, auricular and ventricular borders can be distinguished from each other on the kymogram, a finding not always present.

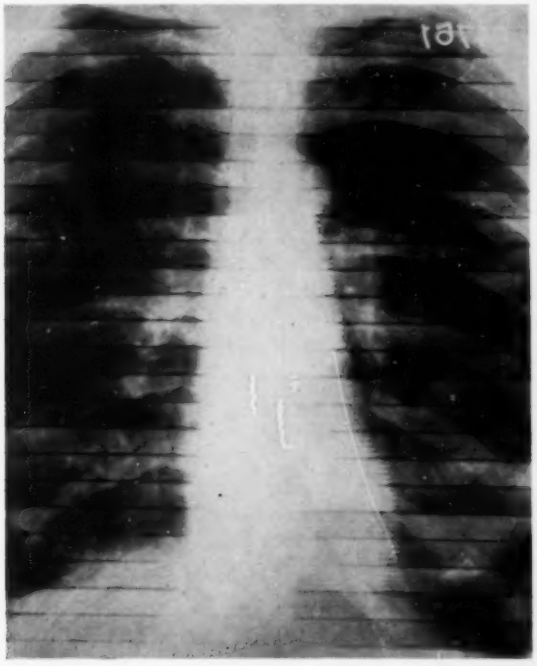

Fig. 1. Case 1. Kymogram of a small normal heart made with the Stumpf grid. The aortic, pulmonic, auricular, and ventricular borders can be distinguished from each other along the left border of the heart silhouette.

Case II. I. Y., male, aged seventy-one. Entered the hospital because of carcinoma of the lip with metastasis to the regional lymph nodes.

Physical examination shows heart and lungs to be clear. No cardiac murmur. Blood pressure: 156 systolic, 90 diastolic. Wassermann and Kahn tests negative. Kymogram taken with the Sundberg grid in a three second run shows normal heart and great vessels for a person this age. The heart rate is recorded at 70 beats per minute. The characteristic pulsations of the great vessels are well registered. The ventricular wave forms show the superimposed notches produced by closure of the heart valves.

Case III. F. M., male, aged sixty-four. Complaint: Shortness of breath for four years. Patient admitted primary syphilitic lesion

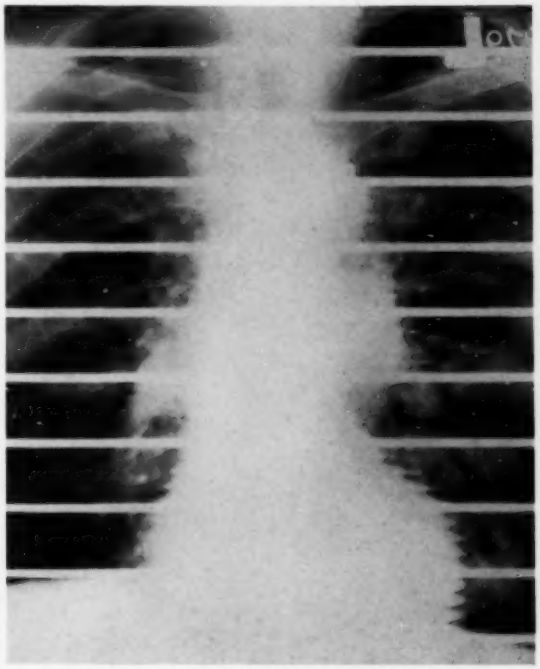

Fig. 2. Case II. Kymogram of a normal heart made with the Sundberg grid showing the wave forms spread out over a 30 mm. panel.

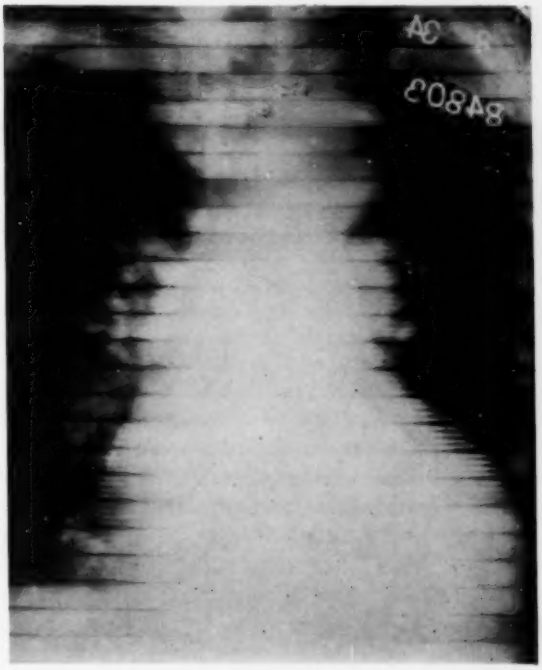

Fig. 3. Case III. Kymogram of an aneurysm of the innominate artery. The pulsations and changes in density of the mass in the upper right mediastinum are well recorded. The increased amplitude of an aortic insufficiency is also present.

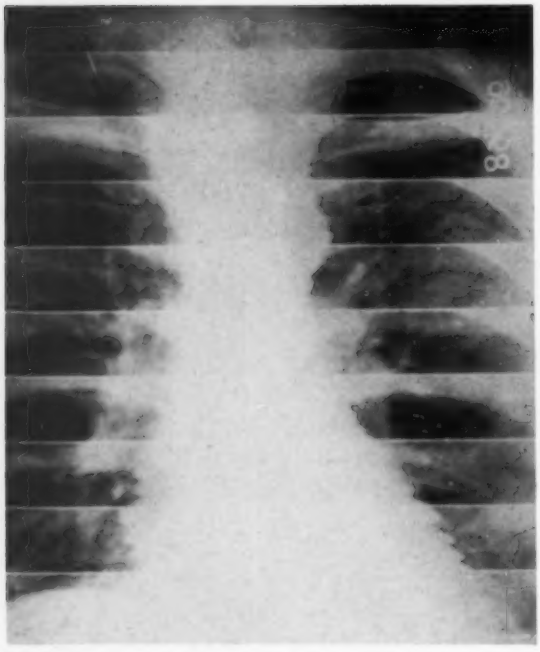

FIG. 4. Case IV. Kymogram of a substernal thyroid. Note the absence of pulsations and the uniform density of the upper mediastinal mass. The recorded waves are not regular, indicating an arrhythmia.

thirty years ago. Inadequate treatment nine months later. Precordial pains for the last five weeks with shortness of breath and orthopnea and swelling of feet and ankles for past ten days.

Physical examination shows the heart greatly enlarged to the left. Retrosternal dullness, pulsations in suprasternal notch. Diastolic murmur over aortic area, marked arterial pulsation. Wassermann reaction 4+. Blood pressure: 178 systolic, 50 diastolic. Electrocardiograph, normal mechanism. Clinical impression: Syphilitic aortitis and aortic regurgitation. Kymogram taken with the Stumpf grid during a three second run records a heart rate of 80. The heart is seen to be greatly enlarged and the aorta widened. The aortic knob is prominent and shows an increased beat amplitude. Both the systolic and diastolic pulsations of the aorta are seen to be of short duration, showing an increased pulse pressure. In the upper right mediastinum there is a curved shadow extending outward and upward from the aortic arch. This shadow shows a variation in density with each heart beat and the margin shows pulsations identical and synchronous with those of the aorta.

Impression. Aneurysm of the innominate artery with accompanying aortic insufficiency.

CASE IV. D. L., male, aged fifty-one. Patient admitted because of hernia. He also complains of nervousness. Volunteers that financial trouble is the cause. Physical examination shows right inguinal hernia. Heart and lungs negative except for dullness at upper end of sternum. Chest films were recommended to rule out aneurysm or substernal thyroid. Roentgenograms of the chest show an upper mediastinal shadow similar in appearance to that noted in Case III (Fig. 3).

Kymograms taken in a three second run with the Sundberg grid show the mediastinal mass to be of uniform density and without pulsations. There is also evidence of a cardiac arrhythmia. A diagnosis of substernal thyroid was made. Electrocardiograph at this time shows premature beats from right ventricle. The thyroid was removed surgically and on microscopic section was found to be adenomatous.

CASE V. J. B., male, aged fifty-four. Complaint: Shortness of breath and swelling of the ankles for five months.

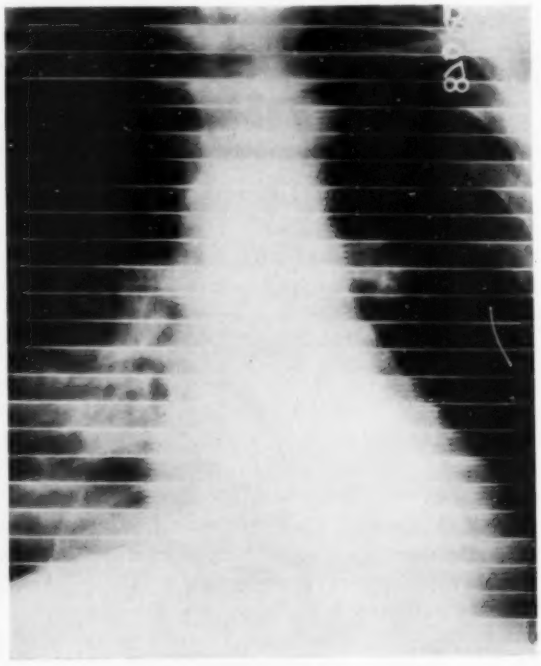

FIG. 5. Case V. Kymogram showing aortic insufficiency. The increased amplitude of the aortic pulsations in the region of the knob are well shown.

The patient had rheumatic fever at the age of twelve. Complete symptomatic recovery. He was refused insurance at the age of twenty-five because of a "bad heart."

About five months before admission the patient began to get short of breath. This increased rapidly in severity and the patient was put to bed.

Physical examination. Dullness of both bases with râles. Loud diastolic and systolic murmur at apex. "Water hammer" pulse. Blood pressure: 138 systolic, 40 diastolic. Wassermann reaction 4+. Electrocardiograph, normal mechanism. Delayed intraventricular conduction.

Clinical Impression. Aortic stenosis and regurgitation, mitral stenosis, cardiac failure.

Kymogram made with the Stumpf grid in a three second run records the heart rate at 75 per minute. The recorded aortic waves show an increased lateral excursion of the systolic limb and a sharp, almost horizontal, excursion of the diastolic limb instead of the sloping curve normally seen. These changes indicate an increase in beat amplitude and pulse pressure. The ventricular waves also show increased amplitude, both the systolic and diastolic limbs being nearly horizontal. It was concluded from these findings that the aortic lesion was largely that of insufficiency with but little evidence of stenosis.

Case vi. F. P., male, aged sixty-nine. Complaint: Shortness of breath for fifteen years; worse for past two or three months. Occasional precordial pain.

Physical examination shows percussion note slightly impaired over left upper lobe with breath sounds impaired over the entire left chest. Heart enlarged to the left. Systolic murmur heard loudest at the base. Blood pressure: 130 systolic, 80 diastolic. Kahn reaction 4+; Wassermann reaction 2+. Roentgen examination shows a large mediastinal shadow characteristic of aneurysm.

Kymogram made in three second run with Stumpf grid shows heart rate of 80 per minute. The ascending aorta shows characteristic pulsations along right margin. The large aneurysmal sac shows no pulsation and no variation of density. It is therefore assumed to be largely filled with thrombus.

Fig. 6. Case vi. Kymogram of an aortic aneurysm. The absence of pulsations and the uniform density of the mass indicates that partial thrombosis has occurred.

The above cases illustrate some of the practical applications of the kymograph in making roentgenographic records of the movements of the heart and great vessels. In spite of our rather meager knowledge of its use, we feel that the kymogram has a definite place in the roentgenographic study of both the normal and pathologic heart. While it is true that any valvular or myocardial damage should produce alterations in the kymographic record, many of these changes are not well understood and no little confusion exists as to the proper evaluation of some of the changes observed. At the present time it would seem that the limitations of the kymograph in the study of the heart are mainly those of the roentgenologist and that the value of its practical application will increase directly with our ability to correctly interpret the kymograms.

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ROENTGENOLOGICAL CHANGES IN CHRONIC ARTHRITIS*

A CORRELATION WITH CLINICAL OBSERVATION FOR LONG PERIODS OF TIME

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THIS study was made to determine what changes would be found in chronic arthritis in serial roentgenograms taken over long periods of time; whether the changes in improvement or retrogression of the disease process were mirrored in demonstrable changes shown in the roentgenogram. Finally, an attempt was made to retrace the course of the chronic arthritis with the roentgenograms in an attempt to discover changes helpful in future prognosis.

There were 73 cases studied, 31 males and 42 females. Forty-five were grouped as atrophic arthritis, 11 as hypertrophic arthritis and 7 showed the changes clinically and roentgenologically which are usually associated with both types (Table 1). The ages at the time of the first roentgenogram varied from three to eighty, with the greater number of patients with atrophic arthritis in early adult life, and those with hypertrophic arthritis almost all over forty-five. Only a few of the patients had roentgen examination in the early stages of the disease. The time interval covered by the series of roentgenograms varied in the various patients between four and twelve years.

The roentgenological changes seen in chronic arthritis over long periods of time vary greatly in different individuals, and in the same individual at different ages, and at different stages of the disease. Such differences have contributed not a little to the confusion in the nomenclature of arthritis and its diagnosis, since there is no distinctive group of changes peculiar to chronic arthritis alone. The study of roentgenograms of the bones and joints in chronic arthritis, however, has shown certain changes which are, in the main, similar and are indicative of definite pathological alterations occurring in evident sequence.

TABLE I

	Sex		Age at Time of First Roentgenogram							Duration of Arthritis							Interim between First and Last Roentgenogram			
Type	Male	Female	1–10	11–20	21–30	31–40	41–50	51–60	Over 60	Months	1 yr.	2 yr.	3 yr.	4 yr.	5 yr.	Over 5 yr.	4–6 yr.	6–8 yr.	8–10 yr.	Over 10 yr.
Atrophic including all subtypes	21	34	8	6	13	17	7	3	1	6	5	10	3	7	3	21	12	22	11	10
Hypertrophic	6	5				1	4	3	3	1	2	2	1	1		4	2	1	5	3
Mixed	4	3				2	1	4				1	2			4	2	2	2	1
Total	31	42	8	6	13	20	12	10	4	7	7	13	6	8	3	29	16	25	18	14

* From the Robert B. Brigham Hospital, Boston.

These roentgenological changes parallel fairly well the gross and microscopic changes as has been shown in the pathological laboratory. Many of the gross morbid changes which take place in the skeletal system in chronic arthritis can be demonstrated roentgenologically and the progress of the disease can be followed.

7. The width of the joint space.
8. Bone atrophy.
   a. Localized, chiefly to articular ends of bone.
   b. Generalized, of the skeleton as a whole.
9. Bone destruction or erosion of subchondral bone.
10. Proliferation of bone.

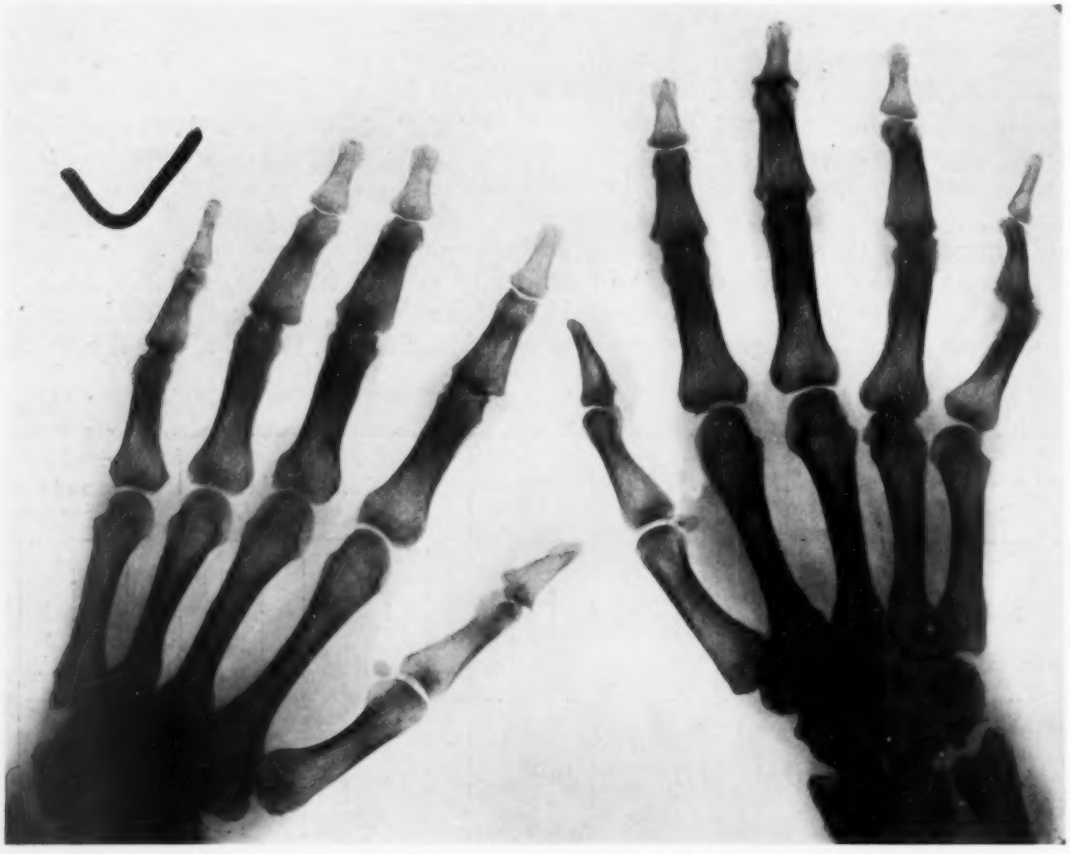

FIG. 1*a*. Female, aged thirty-nine. Roentgenogram taken November 30, 1925. Atrophic arthritis of five years' duration. Joints swollen and painful. Decalcification particularly about the finger joints, narrowing of joint spaces, destruction of bone and cartilage.

The changes commonly interpreted in roentgenograms in chronic arthritis are:

1. Swelling of the entire joint.
2. Increased thickening of the articular capsule.
3. Fluid in the joint cavity.
4. Calcified bodies in or about the joint cavity.
5. Calcification of the blood vessels.
6. The condition of the ligaments in relation to joints.
   a. Pure bony outgrowth, as hypertrophic spurs.
   b. Heterogeneous—as about the hip joint in morbus coxae senilis.

Practically all of these changes mentioned can be demonstrated in roentgenograms of patients with chronic arthritis. Their order of occurrence and variations from time to time make possible, with other data, a diagnosis of the so-called type of chronic arthritis and an appraisal of the progress of the disease (Fig. 1).

The great number of terms used by various observers to describe the different types of arthritis and the changes which occur in the same patient from time to time as the disease progresses have been very confusing both to the roentgenologist and to the clinician. We are indebted particularly to the American Committee for the Control of Rheumatism for reducing the classification to two types: atrophic and hypertrophic arthritis. This gives the most practical division from a clinical[6] and pathological[13] standpoint in the present state of our knowledge. This classification will be used throughout this study as it has the sanction of most widespread usage;[3] in the American literature, atrophic and hypertrophic arthritis, and in the British literature, rheumatoid and osteoarthritis, with varying subclasses of each main division. The belief has wide acceptance that atrophic arthritis and hypertrophic arthritis are systemic diseases with articular symptoms as their most obvious and troublesome manifestations and that both of these types of chronic arthritis are often the result of similar etiological factors.

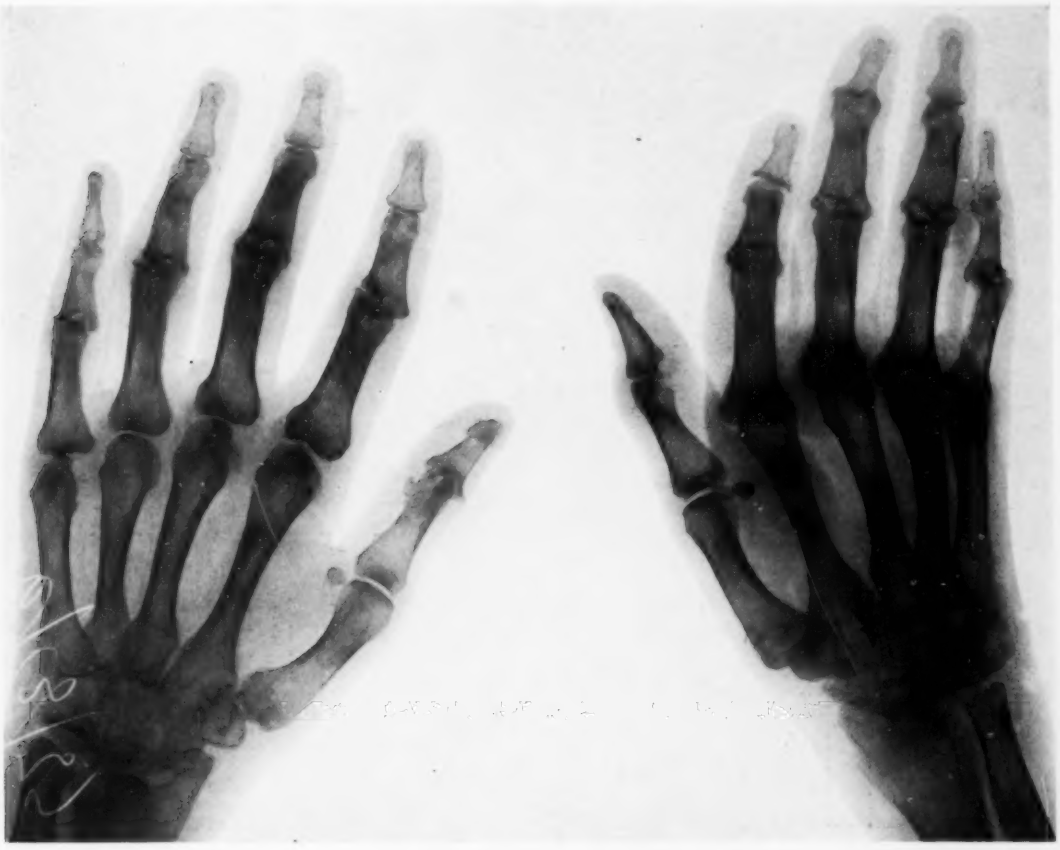

Fig. 1*b*. Same patient aged forty-seven. Roentgenogram taken June 13, 1933. Arthritis active after remission. Increasing atrophy of bone, more destruction of bone and cartilage, soft tissue swelling and increasing deformity.

Few students of arthritis, so far, have had the temerity to suggest that classification in arthritis be wholly discarded. The day, however, may not be far distant when division of types in chronic arthritis will become obsolete and articular changes will be looked upon as signs of general physiological disturbance, varying in their nature largely upon the anatomic type and age of

the individual with his peculiar endocrinal and neurological equipment.[4] The duration and extent of the changes will depend upon the varying dominance of the etiological factors and upon the resistance and adjustment of the individual. Such a hypothesis seems to be the only one logically tenable in an attempt to correlate the roentgenological changes in this study with the clinical and pathological data at hand.

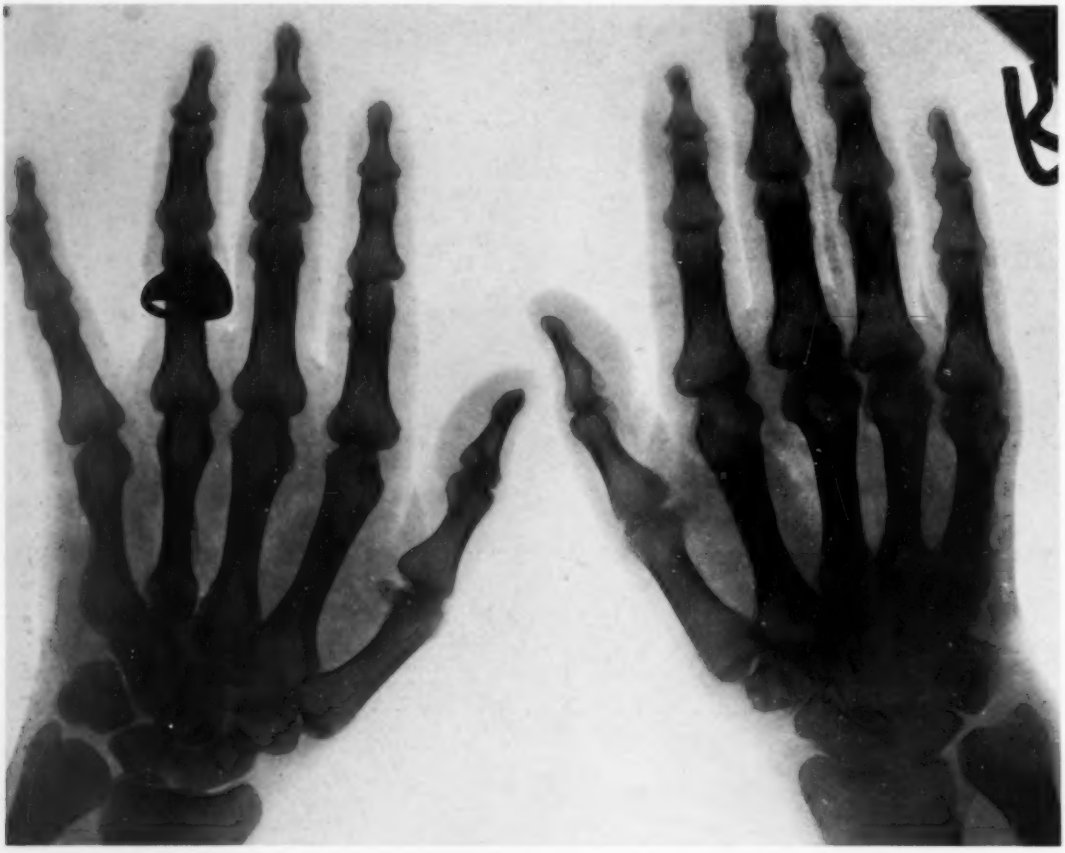

FIG. 2*a*. Female, aged twenty-six. Roentgenogram taken January 14, 1925. Atrophic arthritis of one year's duration, clinically active. Some decalcification about the joints. Slight narrowing of articular spaces. Periarticular swelling, no deformity.

Throughout medical history man has been prone to classify obscure disease processes by readily observable phenomena. We have come a long way from Sauvage who in his "Nostolgia Methodica" published in 1763, divided arthritis into fourteen forms. Only when proof is forthcoming of single etiological factors in chronic arthritis will a satisfactory nomenclature of the disease be compiled. No classification based wholly on clinical, pathological or roentgenological appearance is satisfactory at present. While roentgenograms are of great assistance in showing the location, the extent, and the progression of the gross pathological changes, the history, physical examination and other laboratory findings should also be considered by the physician in making a diagnosis of the type and severity of the arthritis present.

There are few purely roentgenological studies of chronic arthritis recorded in the literature, although roentgenological observations have been mentioned frequently in clinical reports. The studies of Rigler and Wetherby,[15] of Scott,[17] and of Chapman[2] have attempted to describe the findings in roentgenograms according to the

usually accepted typing of chronic arthritis, although admitting the difficulty of diagnosing types of arthritis from roentgenological studies alone.[5,16] The usually observed changes in roentgenograms have been catalogued in the reports of the American Committee for the Control of Rheumatism,[8] and also by the Committee on Rheumatism[3] of the British Medical Association.

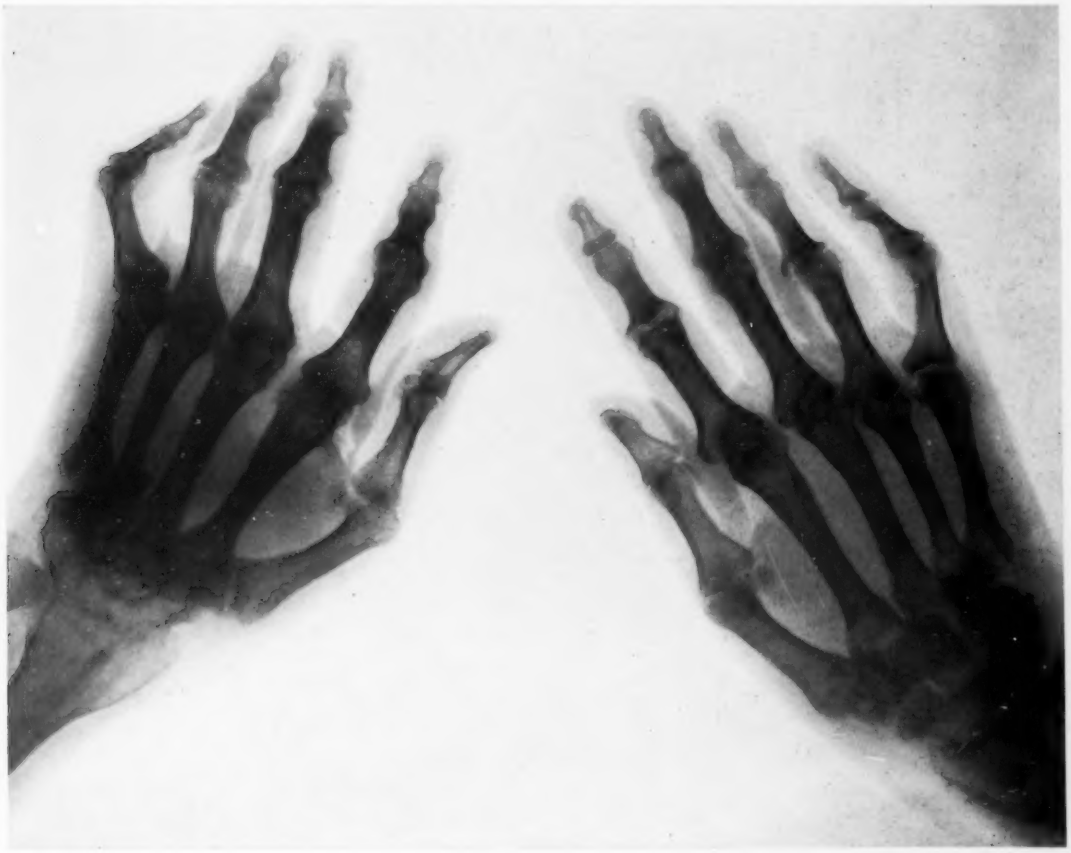

Fig. 2*b*. Same patient, aged thirty-five. Arthritis quiescent. Increased decalcification, cartilage destroyed about the joints. Phalanges have become shortened. Beginning ankylosis of interphalangeal joints, slight deformity of fingers.

The reactions of bones and joints to injuries or to various internal pathological disturbances are quite narrowly limited. The roentgenological changes observed, consequently, will be the result of a small number of pathological disturbances varying in their intensity and combinations. With slight trauma or mild infection, we may observe productive changes about joints, and increased thickening and density of synovial tissues. Where strong ligaments are attached, spurs may appear, with outline and density which may be sharp or indistinct depending largely upon circulatory alterations and upon the effectiveness of the mineral metabolism at a given time. Increased circulation can produce atrophy of bone and impaired circulation may produce a picture suggestive of increased density of bone as Phemister[14] and others[1] have shown. Neurological disturbances, frequently observed in patients suffering from chronic arthritis, can indirectly lead to bizarre changes in the skeletal system. With severe injury there may be death of bone and partial or complete destruction of joints (Fig. 2).

With long continuation of disease, de-

formities may appear. If joints are used in a deformed position, a certain amount of adaptation may take place in the form of the joint on account of the changed function. Both atrophic and hypertrophic arthritis may show increased density or decreased density of bone, particularly in mixed types of arthritis. It is common, however, to see the atrophic form of arthritis in individuals of the slender type with less dense (decalcified) bones and the hypertrophic form of arthritis in persons

FIG. 3*a*. Female, aged fifty-one. Roentgenogram taken January 18, 1926. Mixed arthritis of nine years' duration. Clinically inactive. Heavy bones, fairly well calcified articular surfaces show only slight damage. Periarticular swelling.

TABLE II

COURSE OF DISEASE

	Roentgen Changes			Clinical Course		
	Retrogression	Improvement	Stationary	Retrogression	Improvement	Stationary
Atrophic arthritis	49	2	4	22	26	7
Hypertrophic arthritis	8		3		9	2
Mixed arthritis	7			3	3	1

of the stocky anatomic type with dense (well calcified) bones. Localized decalcification and apparent cyst formation are often observed about the metacarpal and phalangeal joints in both types of arthritis and about the larger joints as the proximal

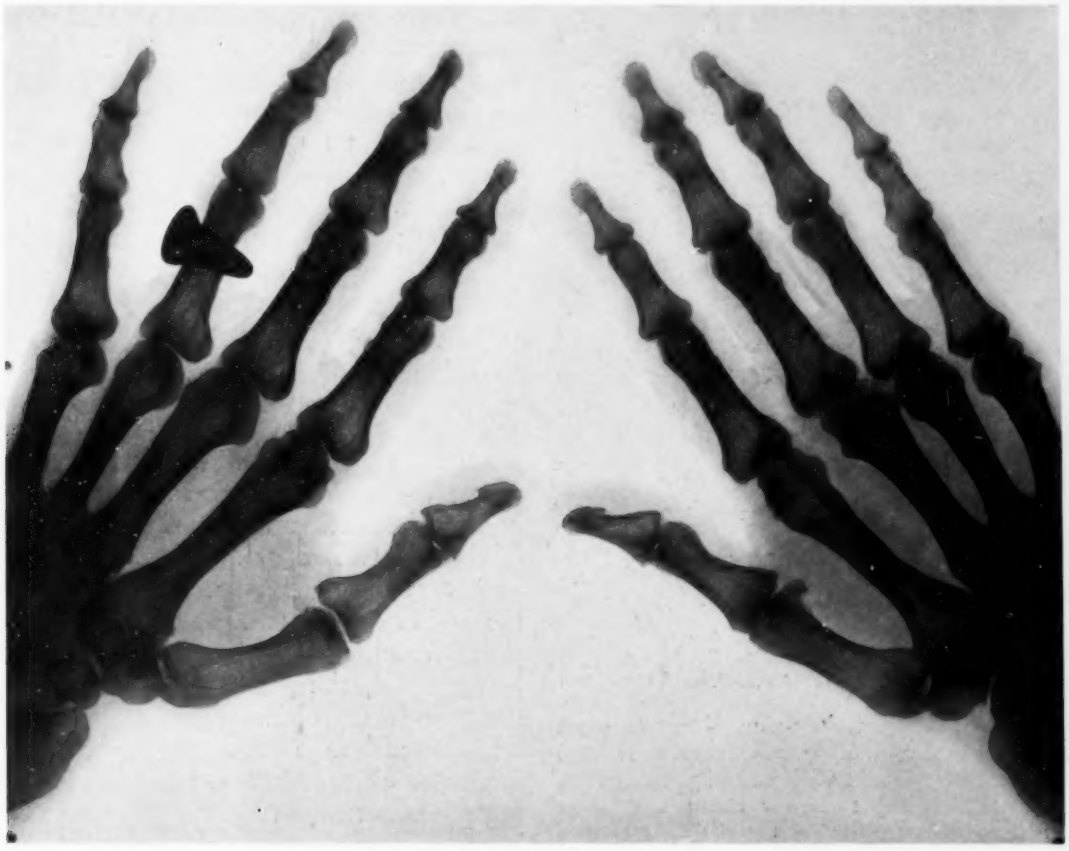

Fig. 3*b*. Same patient, aged sixty. Clinically inactive, no disability, increase in decalcification. Slight bony proliferation about finger joints. Increased narrowing of articular spaces, no deformity.

end of the tibia and femur in hypertrophic arthritis.[11] In some cases this apparent cyst formation persists; in others, healing has probably taken place in both types as shown in roentgenograms.

Shortening of long bones, and particularly of the fingers, is not an uncommon observation in the atrophic type, with apparent telescoping of the bone and widening laterally at the articular margin. In children retardation of growth and early epiphyseal union is often seen in so-called Still's disease, atrophic arthritis of childhood.[12] Calcification of ligaments particularly about the spine and pelvis, less commonly about the hip and knee, was a feature seen almost exclusively in the atrophic form of arthritis. This apparent calcification of ligaments varied markedly in its sharpness of outline. In a few cases with marked clinical improvement, such ligamentous calcification almost wholly disappeared but in most patients it persisted with gradually increasing bony ankylosis of the joints; in the spine with continuance, as a rule, of the intervertebral fibrocartilages apparently unchanged.

The changes both in the clinical course and in the serial roentgenograms were labeled for convenience as retrogression, improvement and no change (Table II). Retrogression meant an increase in the

morbid changes shown by roentgenograms. Improvement indicated an approach to more normal looking roentgenograms; in the atrophic form of arthritis, decreased radiability of bone, cessation of the destructive changes in the articulations and decrease in deformity. They were called

FIG. 4*a*. Female, aged sixty-nine. Roentgenogram taken June 11, 1933. Hypertrophic arthritis of two years' duration. Slight stiffness and pain in joints. Heavy bones, slight atrophy about the finger joints, slight narrowing of the articular spaces. Calcification of blood vessels, bony proliferation about joint margins.

stationary when no appreciable change could be seen in serial roentgenograms. In the atrophic group of arthritis there were 49 that showed retrogression, 2 that showed improvement and 3 that remained stationary. The hypertrophic group showed 8 with retrogression and 3 stationary. In the mixed group with both hypertrophic and atrophic arthritis (the hypertrophic changes usually preceding the atrophic ones) there were 7 patients, all of whom showed retrogression roentgenologically (Fig. 3).

The latter part of Table II attempts to correlate the roentgenological findings with the clinical course. As the figures show there is little statistical correlation between the clinical and roentgenological changes. Individual cases in either type, however, were exceptions in that improvement or retrogression roentgenologically and clinically were recorded in almost equal degree from year to year. In either type, the changes as shown by roentgenograms in the bones and joints, once begun, tended to progress no matter what the clinical status of the patient might be or how good the articular function. Only this could be observed; with improved function of that body, the progress of the morbid changes became slower and tended to become stationary sometime subsequent to the quiescence of the clinical disease. In only 2 patients with atrophic arthritis was improvement observed in the roentgenograms. Apparently, as experimental evidence suggests,[10] repair in articulations[9] and recalcification of bone, in the presence of chronic disease, takes place very slowly and very imperfectly under our present methods of treatment. It was also noted, that the older the patient, other things being equal, the greater seemed the tendency to retrogressive changes in roentgenograms although clinical improvement might be observed. While much advancement has been made in clinical study and in improved therapy, the repair of the morbid changes and the limiting of the articular and osseous damage in the aged offer a challenge to further therapeutic endeavor (Fig. 4).

The fusion and obliteration of the sacroiliac joints were studied in those cases where serial roentgenograms of the sacroiliac joints were available. Fusion of the sacroiliac joints is commonly observed in old age, but when it is seen before the age of forty it is commonly looked upon as the result of disease. We know that the spinal type of atrophic arthritis begins frequently with clinical symptoms referable to the sacroiliac and lumbosacral articulations,[18] and that ankylosis of these joints often oc-

curs early in the course of this disease. Table III shows that fusion of the sacroiliac joints was most commonly found in this study in atrophic arthritis of the spine, but was seen not uncommonly with other types of arthritis. Where severe arthritis was present, ankylosis of the sacroiliac joint was apparently as common in young persons as in elderly ones. All of the patients with hypertrophic arthritis who had serial roentgenograms of the sacroiliac joints were well past middle life; and fusion of the joints in all of these individuals but one was probably a combination

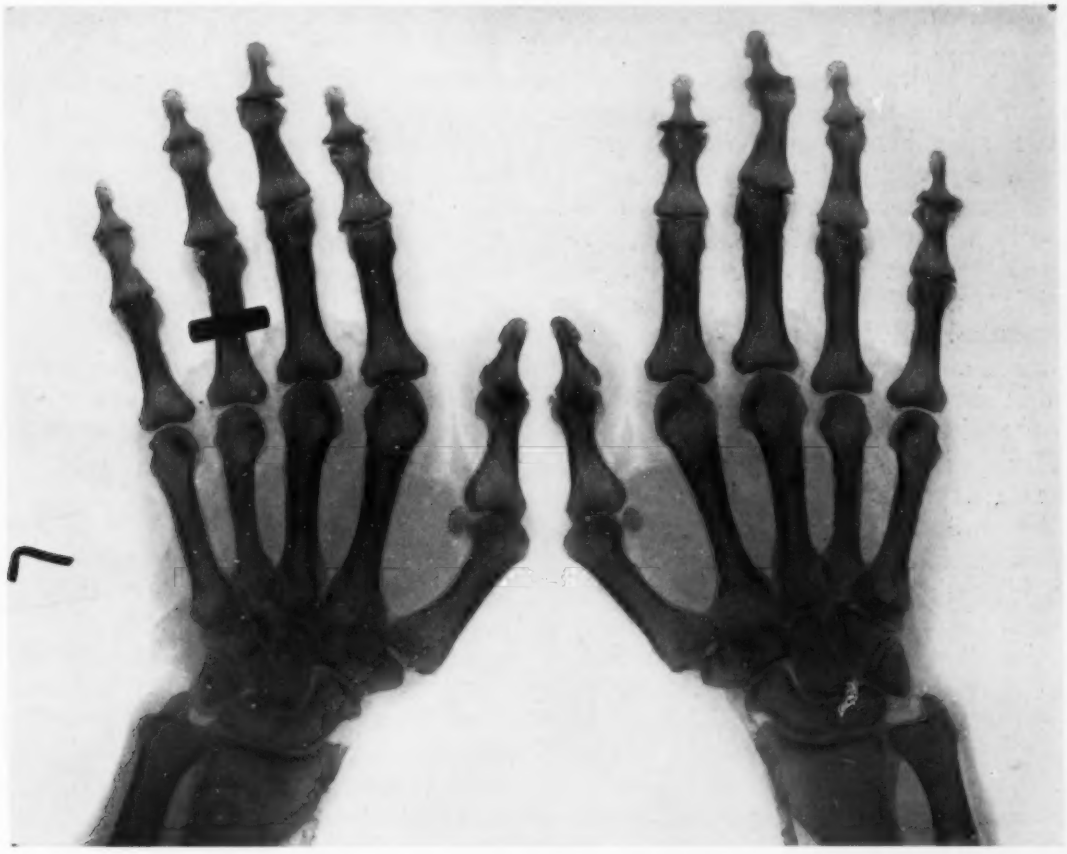

Fig. 4*b*. Same patient, aged seventy-nine. Arthritis quiescent, no disability. Increased proliferation of bone. Increased calcification of blood vessels, no other definite change.

Table III

ROENTGENOLOGICAL CHANGES IN SACROILIAC JOINTS

Type	Males	Females	Fused	Destructive Change	Normal
Spinal atrophic arthritis	6	0	6	0	0
Still's disease, Atrophic arthritis in childhood	1	2	1	2	0
Atrophic arthritis, all other forms	7	7	12	2	0
Hypertrophic arthritis	6	2	7	1	0
Mixed arthritis	3	0	1	2	0

of the disease and the natural changes incident to old age.

In our attempt to evaluate the findings in this group of patients we were led to believe that, in the past, too much emphasis had been placed upon roentgenograms alone, without using them and interpreting the changes which they revealed with all available data obtained from a study of the patient. The marked variations in the roentgenological changes showed that no definite diagnosis or prognosis could be made safely from them alone. The appearance in roentgenograms revealed only the gross pathology in the joints of a constantly varying systemic disease. There were bizarre findings in the extreme destruction of joints with long continued non-use and all gradations of imperfect repair. In the serial roentgenograms in middle adult life and in the aged the differentiation of types of chronic arthritis became increasingly difficult with age or long duration of the disease and the roentgenological changes which we had been accustomed to call the manifestation of atrophic or of hypertrophic arthritis were frequently found to merge. The atrophy of bone, the narrowing of the articular space, the destruction of the joints and the proliferation of bone presented no typical characteristics which differentiated them from other diseases affecting joints, with this exception that the morbid changes in chronic arthritis occurred usually much more slowly. For example, an ankylosis of the hip joint of many years' duration occurring in chronic arthritis presented a similar picture, in the end-result, to ankylosis following acute disease.

Very few bones showed any recalcification or any improvement in the marked atrophy in subsequent roentgenograms. In this they differed from the finding in traumatic injuries where complete recovery from bone atrophy (as shown in roentgenograms) is observed on the resumption of normal function as in fractures of bones. Whether the wide extent of the pathological changes and the continuance of the disease in spite of apparent clinical recovery prevent repair of the osseous atrophy, we cannot tell, although an assumption that this is the case seems to be logical. Definite correlation with the clinical course was observed in only a few of the cases. The progression of the changes observed in roentgenograms, long after apparent quiescence of the disease, would suggest that a more exact method of determining the activity of the disease than the methods now at our command was needed. The improvement observed in roentgenograms subsequent to clinical improvement was slow and was more often a cessation of destructive changes than an actual repair of the pathological changes which had already occurred. A manifest rapid ageing of the bones and joints in young people was seen with no later return to the usual picture for that age-period, when normal activity was resumed and the disease was seemingly no longer active. Union of the epiphyses of the long bones in children was found apparently as a reparative attempt in convalescence from atrophic arthritis in childhood. Transverse striations proximal to the metaphyseal region were observed with each exacerbation of the arthritic symptoms in growing children. Ossification of the costal cartilages was frequently found much advanced beyond the age of the individual and in the presence of increasing atrophy of bone. The occasional spontaneous fractures which occurred with the marked atrophy of bone healed normally in the cases observed.[19]

CONCLUSIONS

1. The changes shown in roentgenograms of bones and joints in chronic arthritis are extremely varied in nature at different ages of the individual and at different stages of the disease. A diagnosis of the type and severity of arthritis should be made only after a careful review of all the data obtained from a study of the patient.

2. Roentgenograms are most helpful in determining the location, the extent, and

the progression of the disease in individual bones and joints.

3. Extensive changes in joints may be compatible with good function. Caution should be observed in prognosis since a good functional recovery is often possible with increasing roentgenological changes in bones and joints. Improvement in the roentgenological picture is rarely seen.

4. The reactions of bones and joints to external or internal injury are limited in nature. The roentgenological changes observed in chronic arthritis differ from changes in other diseases of bones and joints chiefly in the slow rate at which they progress.

5. Correlation of the serial roentgenological changes with the clinical course was the exception. The morbid changes observed in roentgenograms usually progressed for a long time no matter what the clinical course or treatment. These changes tended to become stationary long after the clinical disease was apparently quiescent. Recalcification of bone and moderate repair were observed in the roentgenograms of only two patients.

6. Fusion of the sacroiliac joints seems to be a fairly common accompaniment of a generalized arthritis and occurs with almost equal frequency in any age group.

7. In older persons, the retrogressive changes in either type of arthritis seen in roentgenograms were often more rapid. The manifestations which have been considered characteristic of atrophic or of hypertrophic arthritis were frequently superimposed as age increased.

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VISUALIZATION OF MINUTE GALLSTONES*
(LAYER FORMATION OF BILE)

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ALTHOUGH the reliability of the Graham test has improved with advances in technique, statistics on its diagnostic value still show a certain percentage of failures. A recent comparative survey of a large number of statistics by Rose[16] showed that the largest percentage of errors occurs in the group of normal cholecystograms. Kirklin,[13] for example, reported in 1928 that out of 331 cases with normal cholecystograms only 270 proved to be normal at operation; 14 were found to have stones, while 47 showed chronic inflammatory changes. We have tried, by means of a special technique, to demonstrate tiny concretions which often escape discovery with the usual method of examination. We also have used this method to interpret more accurately faint gallbladder shadows. In the course of this study we observed the phenomenon of floating stones, which hitherto has been reported by only three authors (Åkerlund,[1] Eliasz,[11] Bernstein[6]).

The method consists in taking roentgenograms of the gallbladder in the upright position with compression technique and aimed exposures. Although this technique has been recommended by a number of authors,[2,6,10,14,17] its superiority in certain cases is not as yet fully appreciated. We are of the opinion that both the upright position and the compression are essential features for yielding the most satisfactory results. Of course the gallbladder should be focused under roentgenoscopic control before the films are exposed. One cannot expect to secure all detailed information simply by taking roentgenograms in the upright position. d'Amato[2] pointed out the advantages of this method for the recognition of pericholecystitic adhesions. He also showed that by it one could more easily differentiate calcified gallstones from calcified mesenteric glands, and gas bubbles from non-opaque stones.

The above outlined technique has been used in addition to the routine roentgenograms in the prone position. The apparatus for taking roentgenograms using compression and aimed exposures was Berg's[3] special equipment. The dye was given according to Whitaker and Ellsworth's[19] "double-oral" method.

We observed several cases with a clinical history of gallbladder disease in which several films in the prone position showed apparently normal cholecystograms. It must be emphasized in this connection that we are well aware of the fact that roentgenograms spoiled by noticeable motion are of no diagnostic value for the demonstration of small stones. When four or five roentgenograms of an individual case were taken, perhaps one among them aroused suspicion of stones. Further investigation of these suspicious cases by means of the above-mentioned technique showed clearly in all these cases numerous small filling defects lying close to each other at the fundic end of the gallbladder shadow (Fig. 1). The explanation for this advantage of the upright position is obvious: The tiny negative shadows caused by the presence of small stones in the dye-filled gallbladder may become easily blurred or erased by the slightest motion (the evidence of which may not be perceptible on the film), particularly because the stones in the prone position are scattered diffusely throughout the gallbladder. In the upright position, however, the small stones sink by force of gravity to the lower pole of the gallbladder and consequently their aggregation forms a rather large area of increased radiance, which is not easily over-

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looked, even with slight motion on the part of the patient. A second reason for missing small stones with routine technique may be too dense a shadow of the gallbladder. With the compression cone of Berg's equipment it is possible to vary the amount of opaque material in the region of the stones until that density is obtained which will give the clearest possible visualization. (Frequently it has been reported in the literature that stones may be obscured by too dense a shadow [8, 10, 17, 18].)

Fig. 1. Small gallstones collect at the lower pole of the gallbladder in the upright position; there was only a suspicion of stones in the prone position.

As a rule, stones of all sizes, whether of opaque or non-opaque quality, collect at the lower pole of the gallbladder in the upright position; but occasionally small non-opaque stones are found floating freely at a certain level in the bile. We observed 3 such cases. In all of them roentgenograms in the prone position yielded no definite information, but in the upright position showed clearly a horizontal row of small radiant defects suspended within the contrast bile. The outstanding clinical feature

Fig. 2*a*. In the upright position small cholesterin stones float at thein terface of biles of different concentrations. Operation revealed numerous tiny cholesterin stones, the size of which varied from 1 to 2 mm. (see Fig. 1).

Fig. 2*b*. Same gallbladder in prone position showing no stones.

of 2 of these cases was the presence of typical severe gallbladder colic. The third case presented less characteristic complaints. In one case operation was performed and revealed numerous cholesterin stones, the size of which varied between 1 and 2 mm. (see Figs. 2*a*, 2*b*, 3 and 4).

Fig. 3. Case II. Floating stones.

Observations of this type of multiple floating stones have been made, as previously mentioned, only by Åkerlund,[1] Eliasz,[11] and Bernstein.[6] Bermond,[5] who reviewed his own material of 650 cholecystograms after the publication of Åkerlund's paper, reported in a recent article that he could not detect any such case among them; but as far as we could conclude from his paper, he did not use compression technique. It should be noted in passing, however, that there have been sporadic reports in the literature of single stones floating within or on the surface of the bile.[4,14]

The peculiar phenomenon of stones floating at a certain level makes it evident that the gallbladder may contain bile of different specific gravities at the same time. The specific gravity of the stones naturally must be assumed to be less than that of the bile below and greater than that of the bile above. But the same observation of layer formation in bile also appears to hold true for normal gallbladders. The average normal gallbladder which casts a uniform shadow in the usual prone position will show layer formation in the upright position, namely, a dense contrast of the fundus fading out gradually towards the neck of the gallbladder (Fig. 5). The ratio of contrast bile to non-contrast bile varies according to the individual case and the size of the gallbladder. Instead of gradual transition in density from the fundus towards the neck of the gallbladder, occasionally a sharp borderline between the constrast and non-constrast bile is found. The significance of this demarcation Bernstein[6] has discussed in an interesting paper.*

While from the foregoing it is obvious that layer formation is present in normal cholecystograms, it remains to be determined whether or not it represents a physiological state of normal bile, or only occurs under the unphysiological conditions imposed by the presence of the heavy

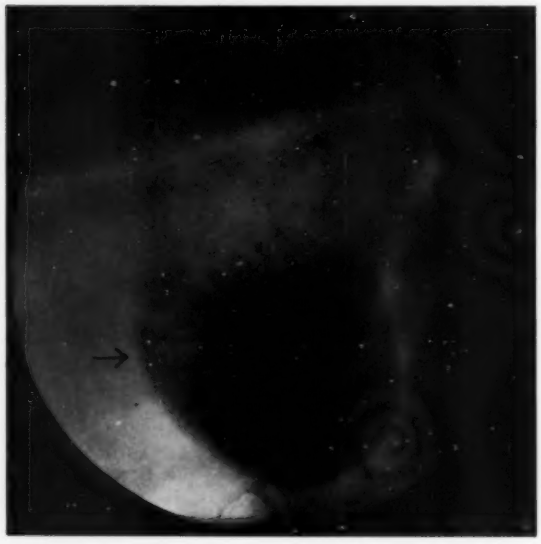

Fig. 4. Case III. Floating stones.

* In this connection it must be stressed, however, that the stones in the reported cases did not float in the transitional zone of density, but within that portion of bile which shows the greatest contrast. Åkerlund explains this by pointing out that the specific gravity and the absorptive quality of media for roentgen rays do not directly correspond to each other (Fig. 4).

iodine atom of the Graham test. The previous conception was that fresh liver bile flowing into the gallbladder mixes with the concentrated bile, which has been stored for some time in this organ. Eliasz[11] carried out experiments by which he proved that this conception must be a fallacy and that layer formation within the bile may be a physiological occurrence.*

Other interesting experiments dealing with the same question have been carried out by Paschoud and Zukschwerdt.[15]

Certain observations in cholecystography now appear in a new light. For example, the observation that some gallbladders increase in density after a fatty meal can now be explained on a more convincing basis. Previously Eisler and Kopstein[9] explained this finding as due

Fig. 5*a*. Normal gallbladder in upright position showing contrast bile in the fundus gradually fading out towards the neck of the gallbladder.

simply to an increased thickness of the contrast layer in the contracted gallbladder. Bronner and Schüller,[7] who made experiments as to the concentrating power of the gallbladder wall in acute and chronic cholecystitis, thought that by contraction of the gallbladder wall its mucous membrane became folded, and that thus a larger absorbing surface is available for the concentrating process. It seems that the

Fig. 5*b*. Same gallbladder after a fatty meal. The gallbladder has emptied the non-contrast fraction of bile and is now completely filled with contrast bile.

latter explanation is not very convincing, as the change in density occurs too suddenly to permit any considerable concentration. After knowing that layer formation of bile exists, it seems obvious that contraction after a fatty meal only needs to remove part of the non-contrast bile from the gallbladder, in order to increase the density of the shadow (Figs. 5*a* and 5*b*).

Finally, I wish to present briefly a new interpretation of a selected group of faintly filled gallbladders. It is easy to imagine that in a large gallbladder the layer of contrast bile, forced to spread in the direction of its longest axis in the prone position, does not furnish enough density to produce a satisfactory shadow. In upright position, however, this gallbladder may show well-concentrated bile in the fundus, while the

* Eliasz poured into a single test tube the different fractions of bile received from a duodenal drainage in various sequences. Never a uniform mixture resulted but the different fractions of bile kept separated, the darkest (heaviest) forming the lowest part of the fluid.

rest of it is filled with bile not yet concentrated. Routine roentgenograms in the prone position will not reveal the presence of various layers of bile as the same roentgen ray travels through both layers. With an adequate technique (i.e. patient lying on his back, plate lateral, roentgen ray being in horizontal direction) Eliasz[12] proved that layer formation naturally also exists in the horizontal position, but does not manifest itself with routine technique. Thus a faint shadow due to the presence of much non-contrast bile may result in the usual roentgenogram, while a film in the upright position reveals a normal, well-functioning gallbladder. There are, of course, quite a number of faint shadows, which do not change their appearance, whether taken in upright or horizontal position. They represent the real pathological group. Thus the upright position permits a very helpful differentiation of various types of faint gallbladder shadows.

The surprising observation that the gallbladder contains bile of different concentrations simultaneously necessarily must lead to a revision of our ideas of the physiology and pathology of the gallbladder.

This paper is presented with the intention of indicating a refined method of roentgen diagnosis of gallbladder disease in selected cases. We do not believe that it is necessary to carry out this type of examination in every case, but it should be added to the routine examination in those cases in which clinical and roentgenologic findings do not agree.

SUMMARY

1. The value of roentgenograms of the gallbladder taken in upright position for the detection of tiny concrements is demonstrated.

2. Three cases are reported in which small concretions not otherwise noted floated at a certain level within the bile.

3. It is concluded from this observation that there is layer formation in bile.

4. The increase of density of the gallbladder shadow after a fatty meal is explained by removal of non-contrast bile from the gallbladder.

5. It is shown that faint gallbladder shadows may be present in cases of normally functioning gallbladders.

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ROENTGEN STEREOSCOPY*

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DIFFERING statements in regard to the value of stereoscopic roentgenograms and the indifference of many physicians while viewing them seem to warrant an investigation as to the worth of stereoscopic roentgenograms and whether or not the value obtained from them compensates for the extra amount of time, money, and care which is necessary in stereoscopic work. After an extensive study of the principles upon which stereoscopic vision depends, and the production of many stereograms under different conditions by both the conventional and special apparatus, and the viewing of them under various conditions by many types of stereoscopes, I see many reasons for roentgen stereograms not becoming as popular as they should. The fault is not in stereoscopy, but is due to errors either in the production of the stereograms or the viewing of them, although it may sometimes be due to faults in the viewers themselves. A consideration is given here to some of the results of the work done on this subject, so that roentgen stereoscopy may receive the credit it deserves and that as much definite diagnostic information as is possible may be gained from roentgenologic work.

A flat or single roentgenogram shows the different objects of a group pressed closely together or piled up on top of one another. We cannot see distance between the far and near portions of the objects. The image appears without form and depth, and always more or less distorted.

Our natural two-eye vision of real objects sees things differently. We can see space around the various small, near objects. We can estimate distance between the anterior and posterior portions of the objects. They stand out in relief, without distortion, so that we can study their size, shape, and position, with considerable accuracy. More careful study of human vision reveals that small objects placed about 15 inches from the eyes appear brighter, with sharper outline and more distinctness, than if they were placed far away. The farther they are moved from the eyes, the darker and dimmer these objects become. When we move an object towards us our eyes converge; the closer to the eyes the object is placed, the more converging the eyes become. As it is moved away the optic axes straighten out, becoming almost parallel when we view at a great distance. It is evident that the more of these facts we reproduce by roentgen stereograms the nearer we will arrive at obtaining the maximum value of our two-eye viewing and analyzing faculties, and the more diagnostic potentialities will be provided.

The lateral views, caused by the eyes being set about 2½ inches apart, help to provide the depth of the object. The nearer the object is placed to the eye, up to 10 inches, the greater the side view or lateral displacement that will be seen; hence, the more accurately we will be able to estimate the distance between the far and near parts of the object. Likewise, the farther the object is placed from the eyes, the flatter the object appears. Similarly, the displacement or lateral views are reproduced in roentgen stereograms by shifting the roentgen tube between the exposures. The more lateral displacement of the objects we depict on the films, the more depth will be seen in the image within the stereoscope; and the nearer to normal the eye displacement we depict on the films, the nearer to normal will appear the size, shape, and form of the object. With the device shown herewith, stereograms were

* The drawings and reproductions are not made to exact scale nor are they intended to be used as stereograms—they are to be used only as an illustration in the analysis.

made which presented various depths. Some caused the image to appear flatter than normal—hypostereoscopic effect—and some produced a very deep image—hyperstereoscopic effect—while in others the object appeared normal in size, shape, and form.

Before discussing my method of producing stereograms, let us place a block or cube on the floor, about 6 feet from the eyes, and hold a book, similar to Figure 1, about 18 inches from the eyes. With both eyes open the cube appears directly back of the book. We can estimate the distance they are apart. We can actually see around the book, studying its size, shape, and position. If we now close one eye the objects appear to shift positions. The farther away the cube is placed, the greater the lateral shifting or displacement becomes. Alternating opening and closing of the eyes causes this lateral shifting or displacement to appear very noticeable, but when both eyes are open the cube and book return to the original position—the cube directly back of the book.

If we now place a camera where either eye is positioned, as shown in the diagram, it is evident that we will obtain a photograph showing what we saw with the eye; that is, the cube will be displaced to one side of the book. If the camera is placed at *L*, in place of the left eye, the cube will be shown at the left side of the book (Fig. 2, *A*), and if we substitute a camera for the right eye the cube will be shown on the right side of the book (Fig. 2, *B*).

We now have two dissimilar pictures (Fig. 2) showing the objects somewhat differently than when we looked at them with both eyes open. When we view either one of these pictures, whether we view with one eye or with both eyes, we always see the objects as the camera viewed them and exactly as we saw them when we viewed them with only one eye; that is, the cube appears displaced laterally to one side of the book and not directly behind it as it appeared when we used both eyes. It appears out of its real position. We cannot tell which is the near object and which is the one farthest away, nor can we estimate the distance between the two objects. The picture looks flat, and without form. It is now evident that neither one of the pictures gives us the information we can get by viewing with both eyes.

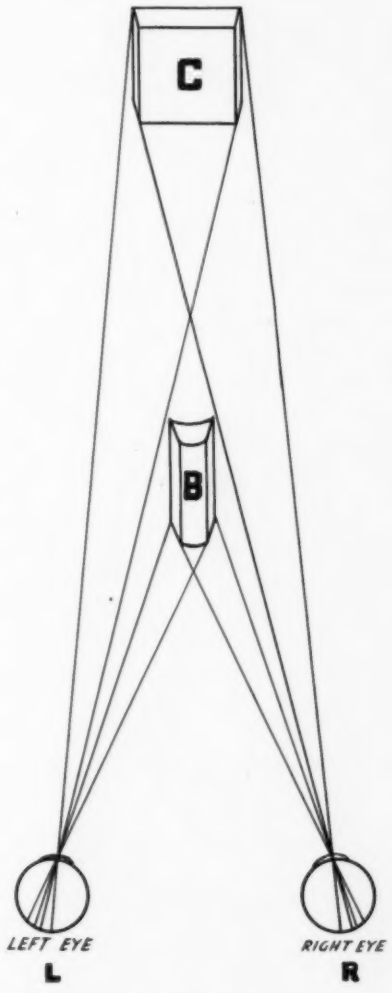


Fig. 1

Instead of the book and the cube, let us now use an object having a size and shape which may easily be kept in mind throughout the analysis—a small funnel will serve the purpose. Reproductions of a pair of roentgen stereograms of such a funnel are shown in Figures 5 and 6. Placed side by side, as shown in either figure, they show some differences. The center of the outlets are pro-

jected to one side and appear either closer together or farther apart than other corresponding points. Were we to view in the stereoscope the stereograms, as placed in Figure 5, we would see one funnel, with estimable distance between the inlet and the outlet; we would be looking in the opening of the funnel with the outlet receding from us. If we now transpose the two pictures, as shown in Figure 6, so that the right-eye picture be viewed by the left eye and the left-eye picture be viewed by the right eye, we see that a marked transformation has taken place. Instead of looking in the large opening of the funnel we now find it pushed back to where the small opening was, and we see the small end standing out towards us in bold relief; we also see space and the same estimable distance from the base to the apex, the difference being a complete reversal of the image. Hence, we have a method, a very convenient one too, for reversing the appearance of the subject.

Therefore, if we can reproduce by photograph or roentgenogram the various factors which have enabled us to see space and distance around the book and to see the objects standing out in relief, and be able to determine their position in relation to one another, we will have obtained, or approached, the maximum value of our natural eye-viewing qualities. If we now examine the pictures separately, we will see the cube displaced to one or the other side of the book, depending upon whether

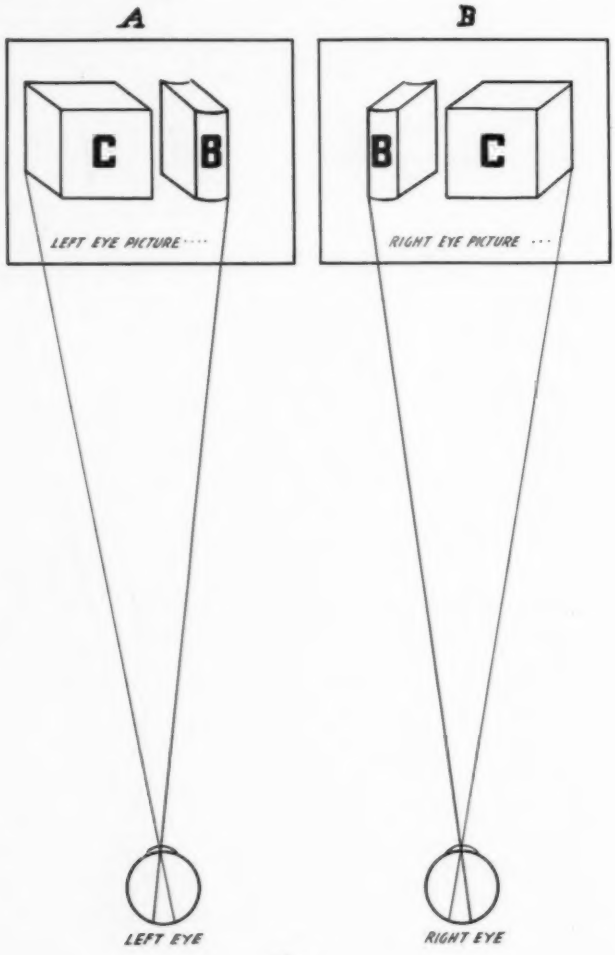


Fig. 2

we look at the left-eye picture or the right-eye picture. If we place these two pictures side by side and compare them, as shown in Figure 2, we find that the pictures of the cube appear to be farther apart than the pictures of the book, and that the two pictures of the book appear closer together

condition as when we viewed the original objects with our two eyes, and we again see the cube return to its original position, directly back of the book. We are now able to judge the distance they are apart and to analyze the form and size and their relation to each other, essentially the same

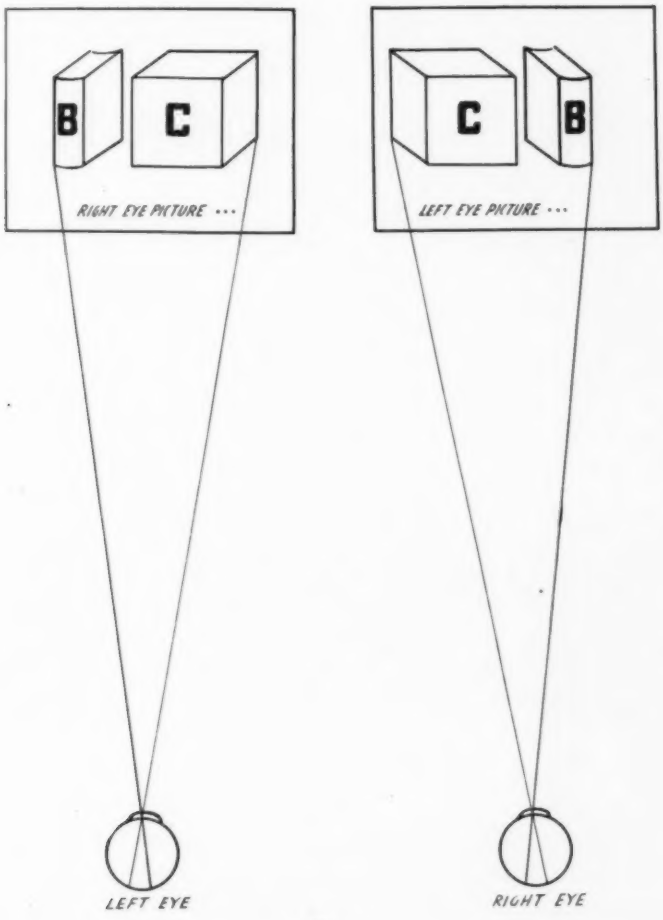


Fig. 3

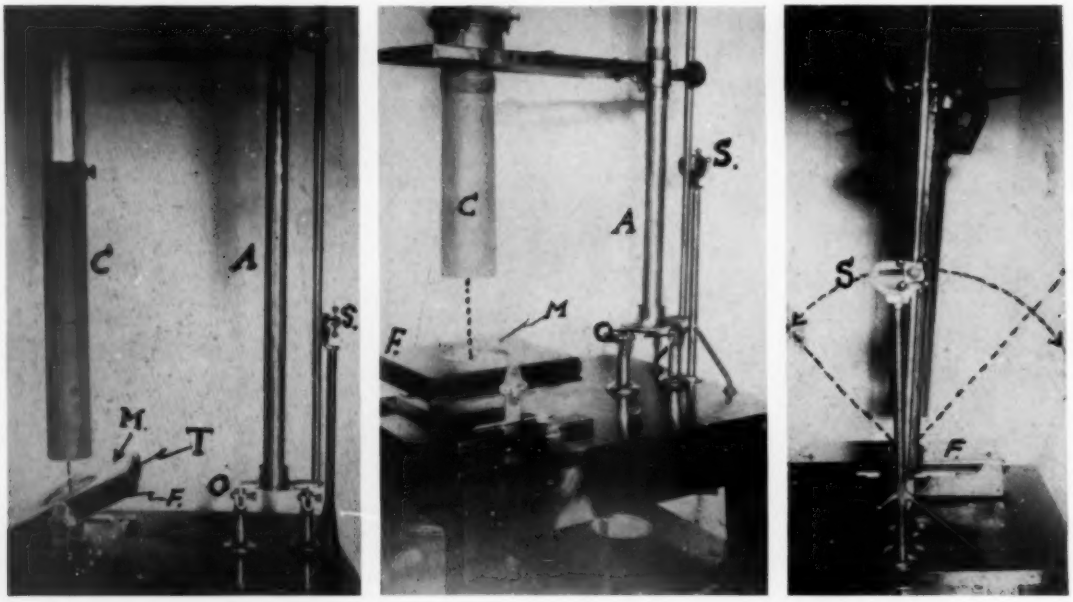
than those of the cube, which is the more distant object. In other words, we find the near objects appearing closer together than the more distant objects. This is the way we saw them when we looked at the original objects with either eye. If we now arrange the pictures so that the left-eye picture is viewed with the left eye and the right-eye picture is viewed with the right eye (Fig.2), we cause a transformation to take place. We have reproduced the same

as we did when we looked at the original objects with our natural eyes.

Let us now transpose the pictures and see what happens. Let us arrange them, as shown in Figure 3, so that the right-eye picture is now viewed by the left eye and the left-eye picture is viewed by the right eye. Referring to our natural eye vision, we find that the near objects appear closer together than the more distant ones; therefore, instead of seeing the book and the

cube, as shown in Figure 1, with the cube back of the book, we now see the cube in front of the book. A transformation has taken place, but we see the same estimable distance between the cube and the book. It is now evident that when such a transformation as this takes place certain fundamental rules and principles must be followed.

Let us now refer to Figure 4, a device which embodies a shift different from the conventional type, which shifts in a parallel manner and which we may term the "parallel ray shift." With the device illustrated in Figure 4, the rays converge towards a common point on the film, which we may term the "converging ray shift." The apparatus consists of a telescoping cone, which I first used in 1916 for sinus work; for research work it has cross threads placed in both inlet and outlet, and attached thereto are a small ball and ring which allow perfect centering of the central rays on the cross lines of the film container. The cassette holder was constructed to permit the making of a pair of stereograms on one film. The apparatus is also equipped with a marking device to assure correct marking of the roentgenograms[1]. This will be described in another article. The upright tube holder, *A*, moves to and fro through an arc, having its center on the level of the roentgen film. This directs the line of the central rays, converging towards the film surface. The slot, *S*, allows the tube stand to be shifted $2\frac{3}{4}$ inches, which is the interpupillary distance of my eyes. *S* was placed at various distances from the film. In this device the distance is 15 inches, which presents the most detail to the viewer. The slot *S* was also made to allow a 180 degree shift from side to side, so lateral stereograms could be made. The film holder, which consists of a box mounted on a level with the film, allows various angles to be obtained, without throwing the central rays out of alignment.



a *b* *c*

Fig. 4

It can now be comprehended that the central rays of the two exposures will converge towards a common point to produce a pair of stereograms, and will coincide with the lines of the optic axes if the eyes are placed in the same position as the targets. And it will be observed that the

lateral displacement of the objects depicted by the rays will equal the lateral displacement seen by the eyes—reproducing the same converging properties when viewed within the stereoscope, thereby fulfilling one of the most necessary fundamental requirements to cause normal stereoscopic effect, where the objects appear to have normal depth, without distortion.

Suppose we now arrange the stop *S* so as to allow the tube stand to be shifted between the exposures more or less than the distance between the eyes; then it can be seen that the lines of the central rays will throw to the side and will not coincide with the lines of sight—"optic axes"—and will depict, on the film, shadows of more or less of the lateral portions of the object than could be seen by the eyes. This lateral displacement will remain constant in the roentgenograms and will be picked up by the eyes in the stereoscope and recombined into a corresponding image, with more or less depth than normal—hyperstereoscopic effect or hypostereoscopic effect.

When the separation of the central rays is more than 10 per cent greater or more than 10 per cent less than the distance between the viewer's eyes, the objects appear either flatter or deeper than normal—hypo- or hyperstereoscopically. The greater the shift is over $2\frac{3}{4}$ inches, the more confusion and distortion is produced, until it is impossible to obtain an understandable image. The less the shift is under $2\frac{3}{4}$ inches, the flatter the picture becomes, until two flat, or single-eye pictures are produced.

Where the conventional parallel shift is used, the minute radiopaque structural constituents are not in the same relative position and alignment with the optic axes as when the central rays coincide with the direction of the optic axes, and therefore, do not permit the converging properties of the eyes as is produced by the converging ray shift.

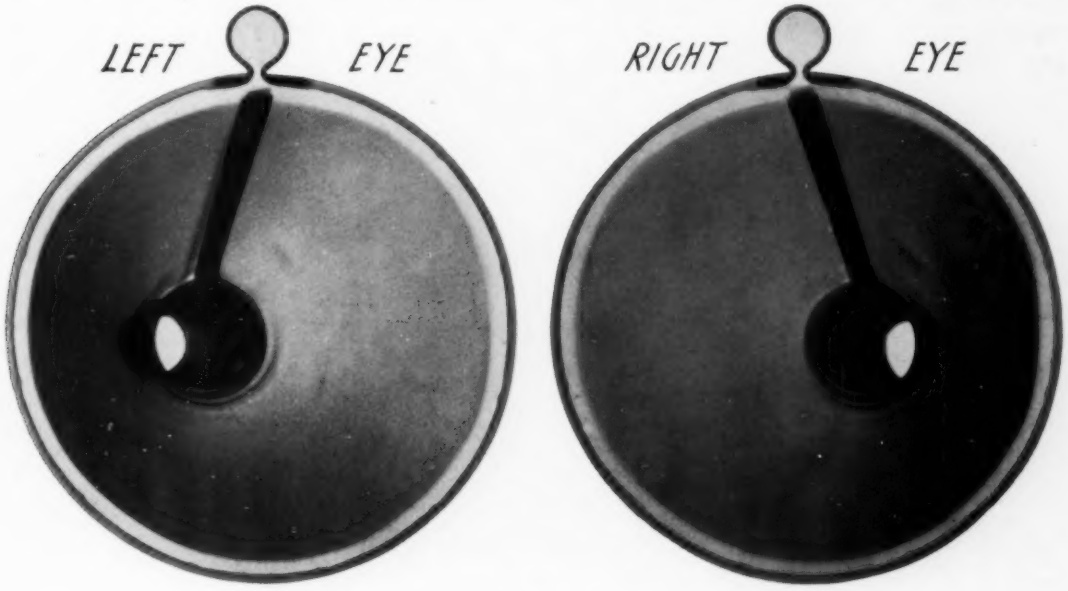


Fig. 5

From the foregoing explanation we can understand that the parallel shift depicts images which should be viewed at a greater distance than we commonly view objects for detail, that is, about 13 inches from the eye. We also find on stereograms made with the parallel shift that the corresponding points on the two stereograms are the same distance apart as the posterior cor-

responding point, which we learn from the example of the book and the cube—the anterior corresponding points are always closer together than the posterior corresponding points.

VIEWING ROENTGEN STEREOGRAMS

To get the most value from our stereograms, it is obvious that we must necessarily produce, as closely as possible, nature's way of viewing—that is, a portion of the object having the most detail and definition will be the near objects, towards us, while the fuzzy and less distinct parts will be the farthest away. We found in our example that this is the way nature views real objects—which means that we ought to view towards the tube, because we know the part down nearest the film will be the brightest and present the most detail and definition. This, then, is what we know as true stereoscopy.

If we now transpose them, as described in Figures 2 and 6, all the objects in the image will be reversed in an orderly manner. The side which was towards the viewer will now be the one farthest away, giving a pseudo-stereoscopic impression.

False stereograms are not really stereograms, but are two pictures in duplicate that are exactly alike. They are often made and passed out as stereograms. If we refer to the example of the book and the cube, we find that we must have two pictures that are not alike. These pictures must be taken from different viewpoints. Instead of false stereograms giving stereoscopic effect they will cause a certain amount of confusion at the receiving and realizing mechanism and will be worse than a plain or flat roentgenogram.

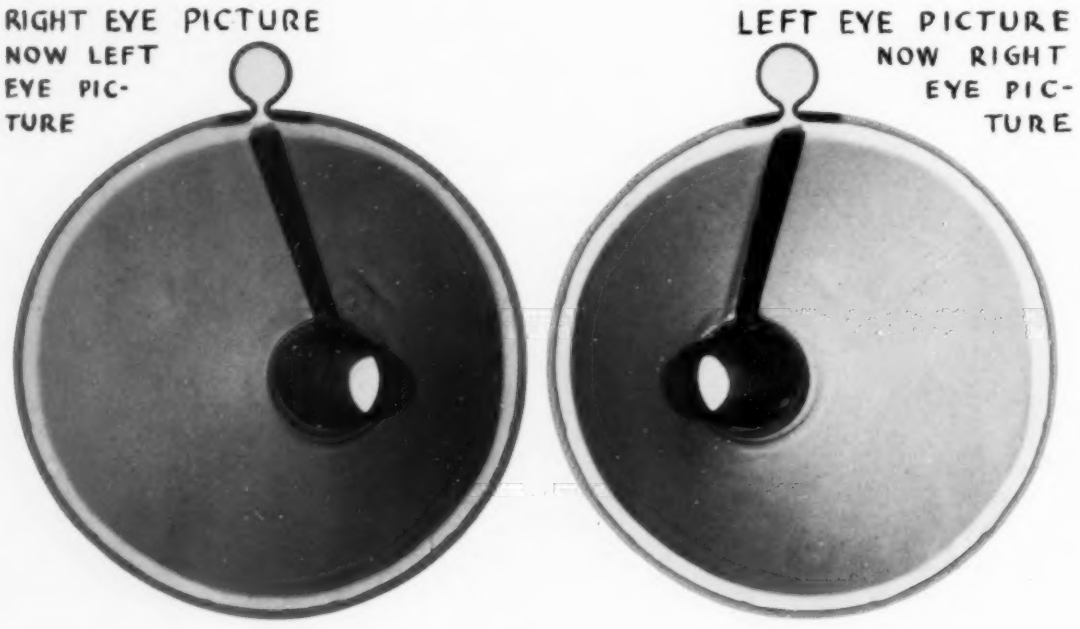


Fig. 6

If we fail to carry out nature's method of viewing there will be a corresponding loss in the value, with a certain amount of confusion, when viewing the stereogram. This is especially noticeable in those accustomed to seeing many single roentgenograms. Thoughts of the appearance of the flat picture must be lost from the subconscious memory, or a conflict will exist between two strong natural forces—one of memories of the flat picture where the two eyes see the same image and the images

on the two retinas are alike, with a force controlling our natural two-eye stereoscopic vision, where each eye sees a different image and two images on the retinas are different. This antagonism causes the viewer to become confused. One may see a different picture—with distortion of the objects; an object may be displaced from its natural position, or one may not be able to cause the two pictures to emerge into an understandable one. But, fortunately, because of our past experience in dealing with our natural two-eye stereoscopic vision, the forces controlling stereoscopic vision predominate, and after a lapse of more or less time at viewing, the memories of the flat roentgenogram are forgotten and the two roentgenograms merge into one image with all the relief and solidity which characterize stereoscopy.

CONCLUSIONS

From the consideration we have just given roentgen stereoscopy we conclude that:

A pair of stereograms consists of two roentgenograms made a certain way, from different viewpoints.

One of these roentgenograms is to be viewed by the right eye and the other is to be viewed by the left eye. The right eye must not see any part of the picture which is being viewed by the left eye, and the left eye must not see any part of the picture which is being viewed by the right eye.

The corresponding points in both roentgenograms must be depicted in sharp detail. One roentgenogram may be somewhat lighter than the other one but the detail and definition must be sharp, so that both pictures merge into one clear image. It is the detail that the eye picks up for the brain to recombine and produce stereoscopic vision.

The direction the roentgen tube is shifted between the two exposures, the distance it is shifted, and the direction of the central rays have much to do with the appearance of the image within the stereoscope.

In addition to normal stereograms, which cause the object to appear in normal depth, hypostereograms can be made, which cause the object to appear flatter than normal, and hyperstereograms can be made, which cause the object to appear deeper than normal.

Transposing the roentgenograms before the eyes in the stereoscope causes a reversal in an orderly manner of all the objects in the stereogram.

True stereograms are more useful in injuries about the skull and face and in bone conditions where close inspection for detail of a certain part is desired.

Pseudo-stereograms are more useful where generalities are considered and exact definition and detail are not so important.

The satisfaction experienced when we are able to see around and between the various objects, when we are able to differentiate between the anterior, middle, and posterior portions of the objects and study them as they stand out in relief and solidity, and when we are able to arrive at a definite decision, more than compensates for the time and care required in stereoscopic work.

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IRRADIATION OF THE ENTIRE BODY BY THE ROENTGEN RAY*

PRELIMINARY REPORT OF 22 CASES

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EXPOSURE of the entire body to the roentgen ray is not a new form of treatment as it was suggested as early as 1907 by Dessauer.[5] In 1922 Murphy and Nakahara[10] reported that a certain defense against cancer appeared to develop after general exposure of mice experimentally inoculated with tumor producing cells. One year later, Kok and Vorlaender,[9] and in 1924 Caspari[2] published papers emphasizing that general body irradiation by the roentgen ray caused regression of tumor masses in experimental animals with smaller doses than were necessary when only the tumor was exposed. Chaoul and Lange[3] applied this principle clinically to 12 cases of Hodgkin's disease which they reported in 1923. Their results were good, 80 per cent of the cases remaining free from recurrences for an average of two and one-half years. The remaining 20 per cent died after intervals of from eight months to two and one-half years.

This method of treatment seems to have been neglected until 1927 when it again appears in the European literature. In this year Teschendorf[14] reports longer remission periods in cases of the leukemias and Hodgkin's disease. Thedering[15] also states that good results followed in skin tuberculosis. Since 1927 many reports have appeared in the European literature. Fuhs[7] has used it with success in treating resistant skin diseases, Schwarz[12] in Hodgkin's disease, Salzmann[11] recommends it for leukemia and polycythemia, and Sgalitzer[13] claims at least a temporary cure over a four year period for one case of polycythemia and favorable results in other similar cases. This type of treatment is known in Europe as "Teschendorf's method" and consists essentially of exposure of the entire body to a hard radiation filtered by 0.5 mm. zinc and 2 mm. aluminum at a distance of 180 cm. A total of 3 to 5 per cent of an erythema dose is given in small daily amounts which are applied alternately to the front and back or opposite sides of the body.

Dale[4] has modified Teschendorf's method by increasing the dose to as much as 4/5 S.E.D. and shortening the distance to 1 meter. His treatments last twelve to eighteen minutes and are given over a period of from four days to five weeks, depending on the reponse of the patient. He treated 8 cases of myelogenous leukemia and all showed improvement. Four of these had not improved previously with local treatment to the splenic area. Their improvement was, however, only temporary. He denies seeing any severe general reactions such as had been reported by other authors. The advantages claimed by Dale are: (1) there is less tendency to develop anemia because the bone marrow receives small doses; (2) a larger number of white blood cells are affected; (3) less general reaction ensues than in heavy doses over the spleen; (4) in covering the entire body it may be possible to get at the organ or organs primarily at fault.

In this country the most notable work has been done by the late Arthur C. Heublein[8] at the Memorial Hospital in New York City. He advocated not only exposure of the whole body but also continuous exposure over a period of many days. Reasoning theoretically, he believed that this would be efficacious in certain neoplastic diseases because: (1) Cells are most sensitive to roentgen radiation when

* From X-Ray Therapy Clinic, Massachusetts General Hospital, Boston, George W. Holmes, M.D., Director. Read in part before the New England Roentgen Ray Society, Boston, February 17, 1933.

immature or in an active state of division as stated by Bergonié and Tribondeau.[1] Although small doses are imperative with continuous generalized irradiation, the dose is large enough to destroy the tumor cell because it is applied at the optimum moment. (2) The body builds up a certain resistance to neoplastic processes under effective radiation therapy.[6] (3) Biologic experiments have shown that general body irradiation causes regression of tumor masses with smaller doses than are necessary with local treatment. (4) Certain types of neoplastic diseases which tend to become widely disseminated early cannot be controlled by local irradiation.

At the Memorial Hospital, to quote Heublein, the results have not been startling, but at the time of his report he was concerned chiefly with working out a tolerance dose for man, and his experiments had been under way only about six months. Also, only cases considered absolutely incurable and with widespread disease were chosen for treatment. Doses as high as 30 per cent S.E.D., 225 r, had been given.

At the Massachusetts General Hospital we have now a series of 22 unselected cases treated in a manner similar to that advocated by Teschendorf. Briefly, the technique employed is 200 kv. (peak), 4 and 6 ma., 0.5 mm. copper filter, and 2.25 meter

TABLE I

DISTRIBUTION OF CASES IN DISEASE GROUPS

	Case No.	Hospital No.	Age	Duration of Disease	Onset of Symptoms	Biopsy	Autopsy
Group I Hodgkin's disease	I	318227	37	8 months	Chest	Yes	No
	II	321862	58	6 years	Skin	Yes	Living
	III	264875	16	14 years	Glands	Yes	No
	IV	302506	53	3 years	Glands	Yes	No
	V	260711	39	9 yr. 3 mo.	Glands	Yes	Yes
	VI	316874	36	3 yr. 1 mo.	Gastrointestinal	Yes	No
	VII	314645	40	3 years	General glandular enlargement	Yes	Living
	VIII	296964	59	4 yr. 9 mo.	General glandular enlargement	Yes	Yes
Group II Mycosis fungoides	IX	11926	60	3 years	Skin	No	Living
	X	319583	58	4 yr. 7 mo.	Skin	Yes	No
	XI	322010	38	15 years	Skin	Yes	Living
Group III Polycythemia	XII	323381	54	6 months	Abdominal pain	No	Living
	XIII	324904	49	11 months	Phlebitis	No	Living
	XIV	323468	38	5 years	Headache	No	Living
Group IV Acute leukemia	XV	323700	3	2 months	Glands	No	No
Group V Lymphatic leukemia	XVI	322855	59	2 months	Weakness	Yes	Yes
	XVII	325263	58	6 years	General glandular enlargement	Yes	Yes
	XVIII	305140	57	8 years	Eyes	Yes	Yes
	XIX	326565	57	5 months	General glandular enlargement	Yes	Living
Group VI Myelogenous leukemia	XX	323468	60	1 year	Genitourinary	No	Living
	XXI	307627	41	2 yr. 5 mo.	Weakness	Yes	Living
	XXII	314592	41	2 yr. 4 mo.	Abdominal pain	Yes	No

distance. The field covers the entire body at one time, and no parts are shielded. The output varies, 20 r per hour is the lowest and 48 r the highest. This value is obtained in air without backscattering. The patient is treated on alternate sides, usually for one hour, on successive days. Two patients able to sit in chairs are often placed back to back and treated at the same time. The greatest average daily dose was 42 r. This patient was the first treated and received a total of 336 r in eight days.

The distribution of the 22 cases in disease groups is shown in Table 1: 8 Hodgkin's disease, 3 mycosis fungoides (1 of the former, Case II, had multiple skin lesions diagnosed "mycosis fungoides" which is not included), 3 polycythemia, one acute leukemia, 4 lymphatic and 3 myelogenous leukemia. Table II summarizes the results

TABLE II

RESULTS OF GENERAL ROENTGEN IRRADIATION

	Case No.	Previous Roentgen Therapy	Effect	Condition Time of General Irradiation	Total r	Duration of General Irradiation	Result and Length of Follow-up
Group I	I	Deep	Poor	F.A.	336	8 days	Poor; died in 3 mo.
	II	S.D.	Good	F.A.	324	22 days	Excellent; living, 5 mo.
	III	Deep	Good	F.A.	396	13 days	Excellent; living, 4 mo.
					410	17 days	Poor; died in 19 days
	IV	Deep	Fair	F.A.	612	24 days	Poor; died in 2 mo.
	V	S.M.D.	Good	F.A.	404	13 days	Poor; died in 3 mo.
	VI	Deep	Good	F.A.	424	16 days	Fair; died in 1½ mo.
	VII	Deep	Good	F.A.	597	20 days	Good; living, 4 mo.
					316	29 days	?
	VIII	Deep	Good	F.A.	120	9 days	Fair; died in 3 mo.
Group II	IX	S.M.D.	Good	M.F.A.	501	14 days	Good; living, 9 mo.
	X	S.D.	Good	F.A.	610	16 days	Fair; living, 5 wk.
					612	24 days	Poor; died in 2 mo.
	XI	S.	Poor	M.F.A.	616	39 days	Poor; living, 1 mo.
Group III	XII	None		Fair	600	29 days	Poor; living, 10 days
	XIII	None		Fair	304	13 days	Good; living, 1½ mo.
					600	34 days	Excellent; living, 4 mo.
	XIV	None		Poor	580	22 days	Excellent; living, 11 mo.
Group IV	XV	1-D	None	Poor	72	3 days	Poor; died in 1 wk.
Group V	XVI	Deep	Poor	F.A.	436	20 days	Poor; died in 2 wk.
	XVII			F.A.	352	12 days	Poor; died in 2 wk.
	XVIII	S.D.	Good	F.A.	329	18 days	Poor; died of pneumonia during treatment
	XIX	None		F.A.	280	18 days	Poor; died shortly after treatment
Group VI	XX	None		M.F.A	360	12 days	Good; living, 3 mo.
					360	17 days	Good; living, 2 mo.
	XXI	Deep	Good	F.A.	504	29 days	Good; living, 3 mo.
	XXII	Deep	Good	F.A.	166	9 days	Fair; died in 3 mo.

Note: S—indicates superficial therapy (100 kv., 0 to 1 mm. Al)
M—medium therapy (140 kv., 4 mm. Al)
D—deep therapy (200 kv., 0.5 mm. Cu).
F.A.—far advanced.
M.F.A.—moderately far advanced.

in each of these groups not only with general irradiation but also with local treatment when used. In tabulating results the following plan was used as far as possible: (1) excellent, if patient showed more response to general irradiation; (2) good, if response was the same; (3) fair, if general irradiation was slightly less effective; (4) poor, all the remaining cases. From Table II we see that the best results were obtained in Hodgkin's disease, polycythemia and myelogenous leukemia. This is not explained by the difference in condition of patients at the time of treatment as all in the first group had generalized and far advanced disease and one case of polycythemia (Case XIV) was in very poor condition. On the other hand, those with myelogenous leukemia were probably somewhat less advanced than the average case.

An abstract of individual case histories follows. Autopsy findings are included where possible.

CASE REPORTS

Group I: Hodgkin's Disease

Case I (No. 318227). J. W. white male, aged thirty-seven. Sudden onset, September, 1931, with malaise, night sweats, backache and sharp stabbing pains under sternum. Developed tender, swollen glands in each axilla and groin and a hacking cough during the first month. In four months had lost 40 pounds. At this time, three months after onset, he first came to the hospital.

Examination revealed pallor, swollen glands, 1 to 3 cm. in size on both sides of the neck, in each axilla and groin, and consolidation of the right lung base posteriorly.

Roentgenogram of lumbosacral spine was negative; chest, homogeneous dullness on lower right. Biopsy of enlarged gland showed Hodgkin's disease.

Roentgen treatment was given to the chest (640 r) covering the diseased area. During the next three weeks he received the following treatment: Supraclavicular glands (660 r), inguinal glands (650 r), lower right chest (660 r) each axilla (630 r). At this time he was considerably improved symptomatically. His chest had cleared and the enlarged glands were practically normal size. He was discharged from the hospital.

In two weeks patient noted all glands to be enlarging but did not return for another two weeks, at which time he had a 4×6 cm. mass in the left neck and enlarged axillary glands. The chest had remained clear. The mass in the neck was given 405 r in one day. General body irradiation was suggested but patient failed to return for one month when he complained of increase in size of all glands and a severe nagging back pain.

Two general irradiations of 60 r each were given on successive days but patient failed to return for another three weeks saying that he had vomited and felt extremely weak after the general treatments. The lower dorsal spine was treated (375 r) but back pain continued.

He was re-admitted to the hospital and a series of general body irradiation was given, a total of 300 r in eight days. During the treatment he had considerable nausea and by the end of the treatment period there had been little effect from the irradiation. He was discharged one week later, improved, the pain in the back nearly gone but the cervical glands not greatly affected.

One month later he was admitted for the third time, at which time a note on his record states: "Terminal phase of lymphoblastoma." The neck glands were given 300 r. At this time he was having severe gastric upsets and had developed a peritonsillar abscess. Ten days later another treatment of 300 r was given to the neck with little effect. Back pain, however, was entirely gone. He gradually became weaker and died two and three quarters months after the last general irradiation and ten months after the onset of the disease. No autopsy.

Case II (No. 321862). N., white male, aged fifty-eight. Onset about 1926 or 1927, with multiple skin lesions diagnosed as mycosis fungoides. On admission to the hospital in 1932 he was underweight, skin was roughened with small bleeding points and there were enlarged glands in the femoral, inguinal, lower abdominal and right axillary regions. Had lost 20 pounds in one year. Biopsy of enlarged glands revealed Hodgkin's disease. The axillary and inguinal regions were treated (600 r). Patient responded well and was discharged.

He returned in two months when general irradiation was begun. At this time he had multiple infected skin lesions, covering nearly

the entire body, marked pruritus and enlarged glands, particularly in the left inguinal region. He was given 324 r in twenty-two days. At the end of the treatment he was considerably improved. In two weeks he was markedly improved, the lesions dry, crusting and disappearing. Glands were considerably smaller. A few refractory skin lesions were cleared by superficial irradiation. Seventeen weeks after last general irradiation there was no recurrence. There were enlarged glands, particularly in the inguinal regions which had remained unchanged. He had gained 13 pounds in weight.

Case III (No. 264875). G. B., white male, aged sixteen, onset 1918. During the years 1924 to 1931 had received roentgen treatment in the following amounts: To the posterior abdomen, 1 S.E.D., anterior abdomen, 6 S.E.D., left neck 2½ S.E.D., right neck 1 S.E.D., spleen 3 S.E.D., posterior chest 2 S.E.D., anterior chest 1 S.E.D. In 1931 and 1932 he received, in addition, more treatment to the lower abdomen, the skull, epigastric and inguinal regions. During this time his general condition had grown worse with increasing anemia, loss of weight and strength. Examination at the time of general irradiation revealed a small epigastric mass and glands in the inguinal region which had been unaffected by local therapy. Blood count: Hb. 30 per cent, red blood count 1,570,000, white blood count 13,000. He was given 396 r over the entire body in thirteen days. General condition slightly improved. Weight loss, however, continued. Hemoglobin and red blood count unchanged, white blood count 5,800. One month later there was marked improvement both subjectively and objectively. Hb. 45 per cent, red blood count 2,100,000. Ten weeks after general irradiation hemoglobin had risen to 60 per cent, red blood count 3,190,000, and he had gained 22 pounds. A pink flush could be seen in his cheeks. There were no palpable glands. He looked better at this time than he had for several years. This remission lasted four months when the liver and spleen were noted to be enlarging. A second series of general irradiations was begun without much effect on his condition and he expired nineteen days after the last treatment had been given. No autopsy.

Case IV (No. 302506). A. N., white male, aged fifty-three. Onset July, 1929, with vague gastrointestinal symptoms, enlarged spleen, and general glandular enlargement, especially in the neck. Response to local treatment, poor. Complaints continued and glands were not much affected. At the time of general irradiation, he had been growing progressively worse for the previous six months, losing weight, complained of weakness and dyspnea, and a moderately severe secondary anemia was present. He was given 612 r in twenty-four days. He became distinctly worse during treatment and one month later an irregular temperature was present. At this time his blood count was: Hb. 50 per cent, red blood count 2,510,000, white blood count 5,600. He grew steadily worse and expired two months after the last general irradiation. No autopsy.

Case V (No. 260711). W. C., white male, aged thirty-nine. Onset July, 1923, when he noticed an enlarged gland at the angle of the jaw on the right which was increasing in size. General symptoms: fatigue, weakness, dyspnea; dry cough and loss of 10 pounds in six months were also present. Response to local treatment, good until September, 1932, when response to roentgen therapy was found to be distinctly less. A lesion in the left knee was unchanged by 1,000 r given in two treatments, two months apart. From September, 1932, until the middle of October, when general irradiation was begun, he received considerable local irradiation with no relief. When general irradiation was begun he had severe pain in the left knee which prevented his walking, considerable edema of the entire left leg, tumor mass, 8 cm. in diameter, above the right clavicle, and another mass, 4 cm. in size, on the anterior chest. There was also a palpable abdominal mass. He was given 404 r in thirteen days with some improvement. Two weeks later, however, patient was distinctly worse and rapidly grew weaker in spite of intensive local irradiation. He died three months after the last general irradiation. This patient had received treatment for eight years and it might be interesting to note the amounts he had received. These are as follows: Left axilla 1,500 ma-min., right axilla 1,100 ma-min., right neck 700 ma-min. plus 600 r, left neck 440 ma-min. plus 200 r, anterior chest 520 ma-min. plus 1,800 r, posterior chest 315 ma-min. plus 2,400 r, anterior spleen 420 ma-min., posterior spleen 1,000 ma-min., left spleen 520 ma-min., anterior abdomen 600 r, posterior abdomen 320 ma-min. plus 2,000 r, right inguinal region 920 ma-min., left inguinal region 160 ma-min. plus 1,114 r, left knee, anterior

300 r, left knee, posterior 700 r, and with general irradiation 404 r. Some of these fields overlap. As accurately as could be determined, 1 ma-min. averages about 4 r. At the time of the last treatment, the body was diffusely tanned, particularly over the trunk, the skin dry and scaling.

At autopsy, all lymph glands were found enlarged. The gastrointestinal tract was uninvolved except for a few tiny plaques in the sigmoid. Small nodules of tumor were found in the liver. Pancreas was normal. The spleen weighed 450 grams, was bound down by adhesions to the surrounding structures, shrunken, nodular, and on section showed several discrete tumor masses. Kidneys and adrenals normal. All of the retroperitoneal glands, as well as the mesenteric glands, were involved in an enormous mass of tumor which inclosed the bile ducts, part of the pancreas, extending to the hilus of the spleen and involving the diaphragm. Below, it involved the ureters, bladder and prostate. Above the diaphragm, the right pleural cavity was found to contain 1,500 c.c. of dark amber fluid and slightly less on the left. The tumor mass on the anterior chest wall extended through the second and third interspaces on the right, filling the anterior mediastinum, infiltrating the pericardium and diaphragm. It involved the tracheobronchial glands and extended in irregular sheets over the hilar regions of the lungs. The upper lobes of the lungs contained scattered discrete tumor masses.

Case vi (No. 316847). N., white male, aged thirty-six, onset October, 1929. Response to local treatment had always been good. General roentgen irradiation was advised when patient began showing little response to local treatment. At this time (November, 1932) he complained of nausea and vomiting, ascites and edema of the legs. His temperature in the afternoon was 102°–103° F. A very mild anemia was present. Hb. 70 per cent, red blood count 4,180,000, and white blood count 3,700. He was given 424 r in sixteen days, after which he was distinctly improved; temperature nearly normal, ascites gone, slight edema of the feet only. Increase in anemia was noted and he lost 18 pounds. For one month his condition remained improved but then he grew much weaker and expired one and one-half months after the last general irradiation. No autopsy.

Case vii (No. 314645). H. E., white male, aged forty. Onset January, 1930, with general glandular enlargement and pallor. He had always responded well to local therapy and had received considerable treatment for over one year. When irradiation of the entire body was begun he had been growing steadily weaker, had developed an unsteady gait, numbness and weakness of the legs and was unable to walk. He was given 597 r in twenty days, which was fortified by local treatment to the spine over the involved area (400 r). Before treatment was completed he was able to walk and was discharged, much improved. One month after the general irradiation no glands were palpable, his appetite was good, and he could walk quite well. He had gained 20 pounds. Four months later, however, he showed general glandular enlargement, pallor, edema of the genitalia and a pathological fracture of the femur. A second series of general irradiation was begun but has just terminated and results are as yet not known.

Case viii (No. 296964). J. B., white male, aged fifty-nine. Onset February, 1928, with pain in the abdomen and generalized glandular enlargement. Had responded well to local roentgen treatment and was in fairly good condition until May, 1932, when the gastric symptoms increased in severity. The disease now showed no response to local therapy. Irradiation of the entire body was undertaken, 120 r being given in nine days. Treatment was stopped because of patient's general condition. About two months after the last treatment he developed a pyloric obstruction. Operation was attempted, but he expired December 15, 1932, nine weeks after the last general irradiation. Autopsy revealed generalized lymphoblastoma involving the stomach in the pyloric region, duodenum, small intestine, colon, appendix, liver, spleen, lungs, kidneys, and prostate. There was obstruction at the ampulla of Vater, with dilatation of the common duct and gallbladder, the latter being filled with thick bile and black sandy material.

The lymph glands of the thorax and abdomen were all involved in the disease process, their structure being completely replaced by the tumor with large phagocytes digesting tumor cells. The bone showed definite aplasia of both red and white cells. Scattered, small, well-differentiated lymphocytes were fairly numerous in it.

Group II: Mycosis Fungoides

CASE IX (No. 11926). G. M., white male, aged sixty. Onset early in 1929, with generalized skin lesions diagnosed mycosis fungoides. Before entering the hospital had had considerable treatment elsewhere, superficial treatment consisted of 1 S.E.D. to eight areas covering the entire body. Had responded fairly well to local therapy. At the time general irradiation was begun the eruptions were localized to the chest and axilla. Much improvement followed after treatment with 501 r which was given over a period of fourteen days. One month later local treatment was again advised, with marked improvement.

CASE X (No. 319583). M. D., white male, aged fifty-eight, onset December, 1927. From December, 1928, until September, 1930, the patient received superficial treatment nearly every week. The local therapy improved the existing lesions but did not prevent new lesions constantly occurring. One year after the beginning of treatment, it was necessary to increase the dose from $\frac{1}{6}$ to $\frac{1}{4}$ S.E.D. Two months later the skin commenced to be tanned. In September, 1930, a gland had appeared in the right axilla, 3 cm. in diameter. Spleen and axilla were treated with deep therapy. Beginning April, 1931, superficial therapy was again used but the results were more temporary than before, and the patient rapidly grew worse. At the time general irradiation was begun he had many skin lesions, marked pruritus, generalized glandular enlargement and a white blood count of 22,500. He was given 610 r in sixteen days. During the general irradiation the red blood count dropped from 5,140,000 to 3,820,000. After completion of this treatment, white count had dropped to 8,000 (the red count rising to 4,050,000), with general improvement. Five weeks later there were some general recurrences. White count had risen to 12,600. He was again given 612 r in twenty-four days with very distinct improvement, the white count dropping to 6,800. He had, however, a secondary anemia, hb. 60 per cent, red blood count 3,640,000. The red blood count continued to drop while the white count rose. He grew very much worse, his white count rapidly mounting, reaching 440,000 two days before he expired.

CASE XI (No. 322010). A., white male, aged thirty-eight. Onset 1917, with more or less generalized skin lesions. All methods of medical treatment tried with poor results. He had had superficial therapy elsewhere. He had extensive generalized skin lesions covering the entire body. He received 616 r to the entire body in thirty-nine days. One month after the completion of treatment there was some subjective improvement but very little change in the lesions. Six months later there was slight improvement following local superficial therapy covering the entire body by small fields. Patient still living.

Group III: Polycythemia

CASE XII (No. 323381). P. S., white male, aged fifty-four. Onset about 1932. Patient complained of marked weakness, mental confusion. Red blood count on admission was 7,430,000. Venesection was done on two occasions, 500 and 300 c.c. of blood being removed respectively without visible change. When general roentgen irradiation was begun six months after onset of disease, his condition was about the same. He was given 600 r in twenty-nine days. Ten days after the last treatment he was discharged from the hospital unimproved and did not return. Ten months later a report was obtained that he was sick in another hospital in this city. The interval history was not obtained.

CASE XIII (No. 324904). A., white female, aged forty-nine. Onset December, 1931. Was admitted to the hospital complaining of advancing phlebitis of the right thigh and lower abdomen, and headaches. She was plethoric and had retinal hemorrhages. The liver was slightly enlarged. Red blood count 7,000,000 to 9,000,000. When general roentgen irradiation was begun her blood count was unchanged. She received 304 r in thirteen days. There was a slight rise in temperature following the first treatment but dropped to normal the following day. Six weeks after last treatment, she was subjectively improved, could see better. Red blood count still unchanged. Phlebitis entirely healed. Patient reports slightly less flow at previous menstrual period. A second series of general treatments was given at this time, 600 r in thirty-four days. Five weeks after the last treatment, headaches were definitely improved, but she complained of a number of boils which had meanwhile developed. Her red blood count at this time was 4,430,000. A week later the boils were disappearing and three months after last general irradiation patient was greatly improved.

Case xiv (No. 323468). E. J., white female, aged thirty-eight. Onset 1927, with headaches and lumbar headache. On admission to the hospital in August, 1932, she was thin and flushed, liver and spleen firm and palpable. She had lost 78 pounds in weight; hb. 80 per cent, red blood count 7,000,000, white blood count 17,000, basal metabolic rate +44 per cent, blood pressure 210/140. Venesection of 800 c.c. resulted in prompt relief of headaches but there was no change in the blood count or blood pressure. One week after admission roentgen irradiation of the entire body was begun and a total of 580 r was given in twenty-two days. Blood pressure dropped slightly, 190/110. Nine basal metabolism tests averaged +32 per cent, the highest +39 per cent, the lowest +26 per cent. Venesection of 500 c.c. was performed during the general irradiation. On discharge from the hospital, there was practically no change in her condition. Three weeks after discharge she returned, having developed dyspnea, orthopnea, hemoptysis, marked pallor, enlarged and rapid heart with a mitral murmur and palpable spleen 4 cm. below the costal margin, liver enlarged below the umbilicus, hb. 60 per cent, red blood count 3,700,000, white blood count 1,400. A diagnosis of subacute bacterial endocarditis was considered but she was not seen for eleven months at which time she had completely recovered.

Group IV: Acute Leukemia

Case xv (No. 323700). C., white male, aged three. Two months before admission had developed enlarged cervical and preauricular glands. Had had one deep roentgen treatment over the spleen. The blood count was: hb. 60 per cent, red blood count 4,020,000, white blood count 34,000. Four days later the white blood count had dropped to 8,500. He was given two general irradiations, of 36 r each, in three days. Meanwhile, the white blood count continued to drop and on day of discharge was 950. He was taken home by his parents against advice and expired one week later.

Group V: Lymphatic Leukemia

Case xvi (No. 322855). A. B., white female, aged fifty-nine. Onset 1924, with glaucoma. Severe symptoms developed one month before entering hospital. Blood count: hb. 50 per cent, red blood count 2,600,000, white blood count 24,000. Local treatment to the spleen produced little change in the patient's condition. During this time the patient ran a fairly constant temperature of 101° to 102° F., at one time reaching a peak of 104° F. The treatment to the spleen produced no visible change, the white blood blood count remaining elevated. A week after the last treatment to the spleen general irradiation was begun. There was the suggestion of a mass in the right upper quadrant, palpable spleen, loss of 13 pounds in weight. She was given 436 r in twenty days. White blood count gradually dropped, reaching a low point of 5,600, three days after the last treatment. With the exception of the drop in the white count there was practically no change in the patient's condition following treatment. During the next two weeks the lymphocytes increased while the polymorphonuclear leukocytes dropped from 32 per cent to 0. The temperature continued to rise and she expired.

Autopsy revealed a remarkably bloodless individual with diffuse destruction of the architecture of the lymph nodes by a solid packing of lymphocytes. No giant cells were found. Liver weighed 1,400 grams and showed infiltration of the periportal spaces. Spleen also was infiltrated, but the architecture was preserved. It weighed 210 grams. Bone marrow was invaded by lymphocytes, the hematopoietic tissue atrophied. The remaining organs were essentially negative.

Case xvii (No. 325263). A. S., white male, aged fifty-eight. Onset 1926, with general glandular enlargement. On admission November 14, 1932, the liver was four fingers' breadth below the costal margin and the spleen two fingers' breadth, evidence of considerable loss of weight and edema of the genitalia. Blood count: hb. 60 per cent, red blood count 3,580,000, white blood count 31,000. One week after admission general roentgen irradiation was begun, a total of 353 r being given in twelve days. During treatment he complained of general malaise, weakness and nausea but did not vomit. Jaundice developed one week later, white blood count increased, having risen to 64,800 just after the last treatment was given. He expired ten days later.

Autopsy revealed leukemic involvement of the skin, spleen, liver, bronchial, mesenteric and retroperitoneal lymph nodes, lungs, pancreas, kidneys, prostate, adrenals, intestines, and even the adventitia of the aorta, and the epicardiac fat contained tumor cells. The fat cells of the sternal, vertebral, and rib marrow

were almost completely replaced by active marrow cells. Among these was a high proportion of completely undifferentiated cells. Mature polymorphonuclears were considerably diminished in quantity. Myelocytes and erythropoietic centers were somewhat less numerous than usual. Very few typical lymphocytes, but plasma cells were numerous.

CASE XVIII (No. 305140). H., white male, aged fifty-eight. Onset about 1924, with general glandular enlargement, difficult vision, increasing irritability and anorexia. First seen in August, 1930. Response to local treatment was always good. At the time general irradiation was given he was in very poor condition, the white blood count having failed to respond to treatment over the splenic area and was 90,000, 92 per cent of which were lymphocytes. The liver and spleen were both enlarged. His weight was down 12 or 14 pounds from the average over the previous two years and there was also a generalized glandular enlargement. He was given 329 r over a period of eighteen days. During treatment, however, he became exposed and developed pneumonia, expiring ten days after the last general irradiation and about eight years after the onset. His white blood count had dropped, however, to 26,000. Hemoglobin and red blood count stayed about the same.

At autopsy a confluent bronchopneumonia in the right and left upper lobes with multiple lung abscesses was found. The lymph node architecture was obliterated by lymphocytes which in a few places were invading the capsule of the gland. No evidence of fibrosis. No evidence of infiltration by tumor cells into the lungs. Liver and spleen, as well as bone marrow, also contained large numbers of lymphocytes. All of these appeared fairly mature. In the bone marrow the majority of cells were lymphocytes. Megacaryocytes were normal.

CASE XIX (No. 326565). M. C., white male, aged fifty-seven. Onset August, 1932, with generalized glandular enlargement, anorexia, and a weight loss of 24 pounds. He had had no local treatment. On admission to the hospital the red blood count was 3,670,000, white blood count 2,450 with 73 per cent lymphocytes. General roentgen irradiation was begun one week after admission. Meanwhile the white blood count had dropped to 1,900 and he complained of marked weakness with severe headaches and an ulcerating lesion of the lower lip. During the first portion of the general irradiation the enlarged glands were decreasing in size. White blood count dropped to the low figure of 400 after 178 r had been given. Two days later white blood count appeared to be on an upward trend, rising as high as 1,700 when the patient developed a severe sore throat and gradually grew worse, the white blood count dropping as low as 250. A total of 280 r over an eighteen day period was given but the patient showed very little response. He was taken home and died four days later. No autopsy.

Group VI: Myelogenous Leukemia

CASE XX (No. 323468). E. M., white male, aged sixty. Onset August, 1931. First seen in the hospital August, 1932, at which time he complained of pain in the left upper quadrant and costovertebral angle for a period of one year. Loss of weight, 5 pounds. Intermittent hematuria which would last two or three days. He had a blowing systolic murmur over the aortic area and an enormous spleen. There were also a few palpable inguinal nodes. His blood count was: hb. 60 per cent, red blood count 3,300,000, white blood count 336,000 to 593,000 of which over 50 per cent were myeloid cells. He had had no local roentgen therapy. Five days after admission general roentgen irradiation was begun. After five treatments there was little change in the white blood count but the myeloid cells had decreased to 28 per cent and mature cells had greatly increased in number. He was given a total of 360 r in twelve days and showed considerable improvement. The white blood count continued to drop steadily and reached a low point of 11,500 of which 18 per cent were myeloid cells. One month later, the white count began to rise. The spleen, which had previously shrunken so that it was not palpable, was now 3 cm. below the costal margin. A month later the white blood count had reached 278,000. The spleen was 6 cm. below the costal margin and a second series of general irradiations was given, 316 r in seventeen days which resulted in a similar response. Five weeks after the last general irradiation the spleen was again below the costal margin. White blood count at this time had risen to 109,000. Local treatment to the spleen was given, 600 r in three days. The spleen shrunk considerably in size, and was still palpable one month later. No blood count is available at

this time. Nine weeks after the last treatment to the spleen, the white blood count was 38,000 and three weeks later it had risen to 136,000, at which time another series of treatments was given to the spleen which resulted in the dropping of the white blood count to 24,000.

Case xxi (No. 307627). J. C., white female, aged forty-one; onset May, 1930. Patient first seen in the hospital July, 1930. Blood count: hb. 46 per cent, red blood count 1,930,000, white blood count 150,000 to 200,000. Response to local therapy had always been good. At the time general irradiation was begun, patient was in very poor general condition, local treatment producing little result. Spleen was 4 cm. below the costal margin. Blood count: hb. 40 per cent, red blood count 1,970,000, white blood count 3,750. Severe headaches. General irradiation was given, a total of 504 r in twenty-nine days, during which time she felt considerably more comfortable. Afternoon temperature of 102° F. fell to normal but there was little change in the blood count. On discharge she felt considerably stronger but expired three weeks after the last general irradiation. No autopsy.

Case xxii (No. 314592). B. A., white female, aged forty-one; onset June, 1930. First admitted to the hospital June, 1931, with an enormous spleen filling the left side of the abdomen and complaining of abdominal pain. Weighed 92 pounds. Blood count: hb. 80 per cent, red blood count 3,400,000, white blood count 480,000 of which 64 per cent were myelocytes. Response to local therapy was very good until she was brought to the hospital in October, 1932, with a temperature of 102° F. and severe vomiting. She was given 166 r in nine days but treatment was stopped because of the rapid dropping of the white blood count which at this time was 2,600. She was improved temporarily, gaining 3 pounds in weight which she soon lost. She gradually became weaker and expired three months after the last roentgen treatment.

CONCLUSIONS

While the number of cases in each of the disease groups is small, there are two things which definitely stand out in the entire series: First, improvement can be brought about by general roentgen irradiation in patients who have ceased to respond to local therapy, and second, this is accomplished with smaller doses than are customarily employed when further treatment is given. It is true that the results are temporary in many cases and that the method is far from being ideal. Nevertheless, the fact that any improvement is obtained in some of the very advanced cases is encouraging. For this reason, I believe a further trial of this type of treatment is justified with a view to refining the technique. It may be that for better results each disease group requires a smaller or larger dose than we have given. This, I feel, is brought out in some of the cases where improvement seems to follow without much change in the blood picture or in the opposite extreme, in those cases where there has been subjective improvement with considerable change in the blood picture. A more thorough study of the blood changes is desirable. Also, it may be that earlier use of general irradiation will be found more effective.

SUMMARY

1. A brief summary of the history of irradiation of the entire body by the roentgen ray is presented.

2. Twenty-two cases treated by this method at the Massachusetts General Hospital are reported.

3. The best results were obtained in Hodgkin's disease, polycythemia, and myelogenous leukemia.

4. The results are indeterminate in acute leukemia because of lack of material.

5. Further trial of this method of irradiation is justified, striving toward refinement of technique.

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LIVER EXTRACT AS A REMEDY FOR ROENTGEN SICKNESS*

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ROENTGEN sickness has remained an unsolved therapeutic problem from the time roentgen treatment was first instituted until the present day. Many remedies, advocated as cures, have been tried and discarded, and up to the present time, no drug or therapeutic agent is known which is specific in its action. The present paper is a report based upon the results obtained with liver extract during the past year and a half. During this period the drug was administered to every patient suffering from roentgen sickness who was willing to take it. For the reader's convenience, results are given in Tables I, II and III.

DISCUSSION

For the purpose of drawing valid conclusions care was taken to avoid psychic factors and changes of technique or dosage. Injections of the drug were withheld until the patient was definitely and obviously suffering from roentgen sickness. Once the liver therapy was started we did not reduce the dose or volume of irradiated tissue except in one case (V.M., Table I) in which one treatment field was discontinued after the third day of the series; in one case the dose was doubled (A.B., Table I, Fig. 1). Our criteria for a state of roentgen sickness were vomiting, which ensued during the treatment or more commonly at a definite time interval after it, and marked nausea between the episodes of vomiting. Every effort was made to eliminate systemic disease or gastrointestinal derangements as causes for vomiting before instituting liver therapy.

The use of liver extract for roentgen sickness is not new. Dietel[1] reported his results in a German periodical in 1933 after experimenting with the drug on a number of patients. In 1934 an article on this subject by Webster[3] appeared in the *British Medical Journal*. Both of these authors reported prompt and satisfactory results with the drug.

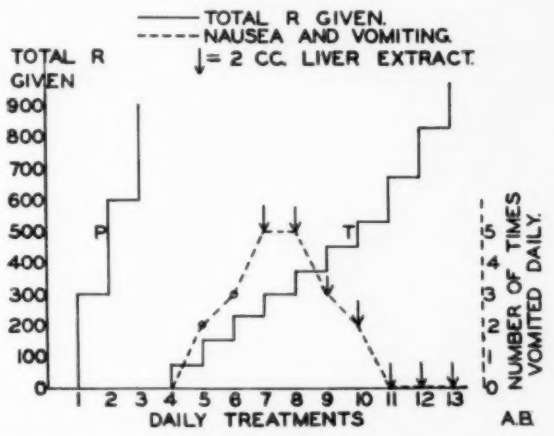

FIG. 1. Complete relief from nausea and vomiting after four daily injections of liver extract. Daily dose of roentgen radiation doubled after cessation of sickness without any recurrence of nausea and vomiting. Curve *P* indicates irradiation given to front and back of pelvis, area being a circle 25 cm. in diameter. Curve *T* represents daily dose to front and back of thorax using a circular area 35 cm. in diameter. Patient received same beneficial effect during second series six weeks later.

Liver extract gives the same results whether injected intramuscularly or intravenously. The drug which we used for intramuscular injection is not suitable for intravenous use but a special preparation for intravenous injection is available. The average dose is 2 c.c. but in a few severe cases we have injected as much as 4 c.c. daily. Webster believes that 2 c.c. is adequate, but Dietel increased the daily dose to 4 c.c. In most cases it is necessary to give this amount daily (provided the roentgen treatments are given daily) if the patient

* From the Department of Radiology, Temple University Medical School. Read at the Thirty-sixth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 24–27, 1935.

TABLE I

COMPLETE RELIEF FROM NAUSEA AND VOMITING
(Sixteen cases)

Patient	Roentgen Ray Area Irradiated Daily Dose (r)	Liver Size of Dose No. of Injections	Clinical Data Response	Method of Injection
Mr. A.B.	300 r front and back of pelvis daily for 3 days, 25 cm. diameter area, then 75 r front and back thorax, daily for 7 days, 35 cm. diameter area. Dose doubled to 150 r for additional 3 days (10 doses in all to front and back of thorax)	2 c.c. daily for 7 days starting after 7th x-ray treatment	Had vomited 2 to 5 times a day until started liver; 4th injection stopped all nausea and vomiting and daily dose of x-ray then doubled. Liver gave equally good results in second series	Muscle
Mrs. C.B.	200 r front and back of pelvis and abdomen daily for 4 days; 3 series of treatments over 25 cm. diameter area	2 c.c. daily for 2 days, after 3rd and 4th x-ray treatments	Confined to bed day before, went to theater night of 1st injection. *Remarkable result*	Vein
Miss C.C.	50 r front and back of entire abdomen for 12 days, 35 cm. diameter area	2 c.c. daily for 2 days starting after 2nd x-ray treatment	Case of Hodgkin's diaease which has had much irradiation. Two doses stopped nausea and vomiting	Muscle
Mr. G.C.	125 r front and back of chest daily for 16 days, 15×15 cm. sq. area	2 c.c. daily for 11 days, starting after 5th x-ray treatment	Roentgen sickness started after 5th x-ray treatment. Two doses liver stopped all nausea and vomiting	Muscle
Mrs. E.C.	150 r each side of cranium daily for 10 days, 25 cm. diameter area; previously had one series	2 c.c. daily for 5 days starting after 5th x-ray treatment	*Spectacular result.* Had vomited 10–12 times a day before liver. First dose cut vomiting to 5 times, second stopped vomiting, 3rd stopped nausea and vomiting	Muscle
Mr. E.E.	125 r each side of neck daily for 24 days; 10×10 cm. sq. area. Total 3,000 r to each area	1.5 c.c. of liver given after 22nd x-ray treatment	Nausea and vomiting completely stopped. Effect lasted for two days despite daily x-ray treatments, then series ended	Muscle
Mrs. J.C.	150 r each side of cranium daily for 10 days, 25 cm. diameter area	2 c.c. daily for 6 days starting after 4th x-ray treatment	Nausea and vomiting relieved after several injections. Same benefit in 2nd series	Muscle
Mrs. A.D.	200 r front and back of peldaily for 5 days; 30 cm. diameter area	2 c.c. daily for two days starting after 3rd x-ray treatment	*Remarkable result.* Had vomited 12 times a day before injection. One dose stopped vomiting; second stopped nausea	Muscle

Table I (*Continued*)

Patient	Roentgen Ray Area Irradiated Daily Dose (r)	Liver Size of Dose No. of Injections	Clinical Data Response	Method of Injection
Mr. C.G.	100 r front and back of abdomen for 6 days, 35 cm. diameter area	2 c.c. after third x-ray treatment and same dose after fifth	First dose stopped nausea and vomiting. Vomiting returned after 2 more x-ray treatments, 2 c.c. liver stopped sickness for second time	Muscle
Mrs. A.H.	125 r front of breast daily for 29 days, total 3,625 r., 17 x 22 cm. area. and 29 daily treatments to supraclavicular region. Total 2,625 r	2 c.c. daily for two days after 24th and 25th x-ray treatments and again after 28th and 29th treatments	Nausea and vomiting relieved after liver. Sickness returned after 3 x-ray treatments without liver	Muscle
Mrs. V.H.	150 r back and 100 r front of lower dorsal and lumbar spine daily for 4 days, 35 cm. diameter area	2 c.c. days of 2nd and 4th x-ray treatments. Drug withheld 3rd day and patient became sick, given 4th day, no sickness resulted	Vomited 12 times day beliver. Liver extract stopped all nausea and vomiting.	Vein
Mrs. F.L.	150 r front and back of abdomen for 10 days, 35 cm. diameter area	2 c.c. of liver extract given after 6th x-ray treatment	Vomited even water before injection. First dose stopped all nausea and vomiting	Muscle
Mrs. A.M.	150 r front and back of pelvis and abdomen daily for 11 days, 35 cm. diameter area. Previously had several series of x-ray treatments	1.5 c.c. of liver extract given day of 3rd x-ray treatment	Nausea and vomiting stopped after one injection. Nausea returned after three x-ray treatments had been given without liver	Muscle
Mrs. V.M.	150 r front and back of lower dorsal spine daily for 3 days then 150 r to back only for an additional 7 days, 15×15 cm. sq. area	2 c.c. of liver extract given after 3rd and 4th x-ray treatments	First dose of liver stopped vomiting, 2nd completely relieved all sickness	Muscle
Mrs. A.S.	400 r front and back of thorax daily for 3 days, 25 cm. diameter area	2 c.c. liver extract given daily, 1st dose soon after onset of vomiting	Vomiting began before completion of 1st day's treatment and was unusually severe. The first dose of liver extract relieved nausea and vomiting	Muscle
Mrs. E.S.	150 r front and back of pelvis daily for 4 days, 25 cm. diameter area	2 c.c. liver after 3rd and 4th x-ray treatments	First dose of liver relieved nausea and vomiting	Muscle

Note: The values given above for roentgens indicate the radiation delivered to each area, at the skin, as measured in air, without back-scattering. In no instance have the roentgens given to separate areas been added together. The other essential treatment factors were: target skin distance, 50 to 70 cm.; voltage, 160 kv. (average) constant potential; current, 5 ma; filters, from 0.5 mm. to 2.0 mm. copper, plus 1 mm. aluminum.

TABLE II

ALLEVIATION—VOMITING STOPPED BUT OCCASIONAL NAUSEA PERSISTED
(Seven cases)

Patient	Roentgen Ray Area Irradiated Daily Dose (r)	Liver Size of Dose No. of Injections	Clinical Data Response	Method of Injection
Mr. S.G.	100 r to front and back of thorax daily for 12 days, 35 cm. diameter area. At same time 100 r given daily to right side of thorax for 12 days, 10×10 cm. sq. area. Previously had much irradiation	2 c.c. liver daily for 2 days after 2nd and 3rd x-ray treatments	Had vomited 3 times after 1st treatment and was nauseated. 1st dose of liver stopped vomiting, 2nd improved nausea but not complete relief. Avoided subsequent injections because of muscle soreness	Muscle
Mrs. M.M.	150 r front and back of pelvis June 20, 23, 26, 28, July 5, 12, 24, 1934, 25 cm. diameter area. Had x-ray and radium irradiation previously	2 c.c. liver day of each x-ray treatment except first	Vomited many times after 1st treatment. Liver extract stopped vomiting but still nauseated. Although disliked vena puncture she preferred it to marked sickness*	4 doses by vein, rest intramuscular. Refused intramuscular but asked for it by vein
Mrs. K.M.	150 r front and back of pelvis and abdomen daily for 12 days, 25 cm. diameter area	2 c.c. liver day of 8th treatment	One dose of liver stopped vomiting but patient still slightly nauseated	Muscle
Mrs. B.R.	100 r front and back of thorax daily for 16 days, 30 cm. diameter area	2 c.c. liver day of 6th, 8th and 10th treatments	Each time liver extract stopped vomiting but never completely relieved nausea	Vein
Mr. W.R.	50 r daily to left face for 49 days, 10×10 cm. sq. area. Previously had much irradiation	2 c.c. liver day of 48th treatment	Marked relief from nausea; vomiting stopped	Muscle
Miss M.S.	150 r front and back of thorax daily for 12 days, 15×15 cm. sq. area	2 c.c. liver day of 5th treatment	Nauseated for 3 days. Vomited several times a day before injection. One dose stopped vomiting and lessened nausea	Muscle
Miss N.W.	100 r front and back of upper abdomen daily for 12 days, 30 cm. diameter area, centered at umbilicus	2 c.c. liver extract daily after 7th treatment until series completed	Nausea and vomiting stopped completely for 2 days after liver but nausea returned	Muscle

* During previous series of roentgen treatments, which had been preceded by 2,400 mg-hr. of radium to cervix, patient developed violent roentgen sickness. First dose of liver, after second treatment, stopped all nausea and vomiting. Subsequent doses of liver given after each treatment kept patient free of all sickness.

TABLE III

FAILURE TO RESPOND TO LIVER EXTRACT
(Seven cases)

Patient	Roentgen Ray Area Irradiated Daily Dose (r)	Liver Size of Dose No. of Injections	Clinical Data Response	Method of Injection
Mrs. M.A.	150 r front and back of upper abdomen, daily for 10 days, 25 cm. diameter area, at same time, 150 r front and back of thorax for same period 21 × 21 cm. sq. area	2 c.c. daily from 5th treatment until end of series	No effect, patient violently ill	Muscle
Mr. W.B.	250 r front and back of upper abdomen daily for 4 days 25 cm. diameter area	3 c.c. liver before 2nd treatment	Patient thought he felt slightly improved but vomited several times despite liver extract	Muscle
Mrs. V.F.	50 r to spleen daily for 16 days, 25 cm. diameter area, given through lateral portal	3 c.c. liver daily from 5th treatment until end of series	Patient vomited several times daily after liver was instituted. Several months before 2 c.c. liver relieved nausea and vomiting on one occasion	Muscle
Mrs. M.F.	200 r front and back of pelvis daily for 5 days. Previously had a similar series of x-ray treatments	2 c.c. liver daily starting after 2nd treatment	No response. Nauseated and vomited throughout series	Muscle
Mrs. E.M.	200 r front and back of thorax and abdomen (dorsal and lumbar spine) daily for 3 days, 10 × 24 cm. oblong area	2 c.c. of liver after last treatment	Nausea and vomited day after series ended	Muscle
Mrs. E.S.	125 r each side of neck daily for 28 days, 10 × 10 cm. sq. area	2 c.c. liver daily from 20th to 26th treatment	*First 3 doses stopped vomiting and relieved nausea*, thereafter liver had no effect	Muscle
Mr. P.S.	250 r front and back of entire abdomen daily for 6 days, 35 cm. diameter area	4 c.c. liver after 2nd, 3rd, 4th and 5th x-ray treatments	No response to liver. Was quite ill and vomited after each treatment	Muscle

is to be kept symptom-free, but in certain cases the beneficial effect will last two days.

There are advantages and disadvantages to both methods of administering the drug. In addition to the occasional difficulty encountered in finding the vein, a temporary untoward reaction is noted at times immediately after intravenous injection. The patients may become pale and feel faint so that it is necessary to have them lie on a couch or bed until the transitory effect wears off. Intramuscular injection of the drug is much simpler but some complain bitterly about the resulting soreness the day after injection. This is especially true in the emaciated, and for them the intravenous method is recommended. A few

patients refused to allow us to continue with the intramuscular injections because of the resulting pain even though their roentgen sickness was alleviated.

We do not believe that it makes any difference when the liver extract is given. Most of the patients received it before the roentgen treatment while others were injected from a few minutes to an hour or two after the treatment.

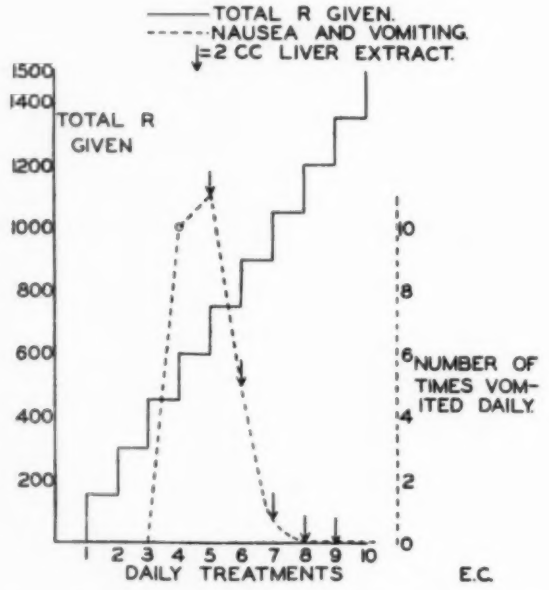

Fig. 2. Complete relief from vomiting after two doses of liver extract but patient was nauseated until third dose was given. (Persistence of nausea shown by tail of curve after last attack of vomiting.) Both sides of cranium irradiated daily using a circular area 25 cm. in diameter.

While relief is not obtained with liver therapy in every case (see Table III), spectacularly good results led us to conclude that its action is specific in some cases. To date, we have been unable to select the type of patient who is likely to be benefited by it so it must be used on every case. Its action is not understood and any explanation of its effect would be entirely speculative and theoretical. As evidence of its specific action on some patients, attention is called to the fact that every patient who was relieved or cured of roentgen sickness during the first series of roentgen treatments had an equally good result from liver extract in subsequent series. It was a temptation to give the injections as a prophylactic during the subsequent series of roentgen treatments to patients who had had good results previously, but with one exception we waited until the illness became obvious.

The response to liver extract may be prompt or gradual. Of the 16 patients who obtained complete relief only 3 needed more than two injections. The response in these 3 cases was so gradual that they were not entirely well until the third or fourth dose had been given (see Fig. 1). As can be seen from a study of the tables, the greater percentage of the patients obtained prompt relief from two doses of liver extract (see Figs. 2 and 3). In only a few patients were we able to completely withdraw the liver extract after the roentgen sickness had been controlled. However, it was possible in many cases to stop the

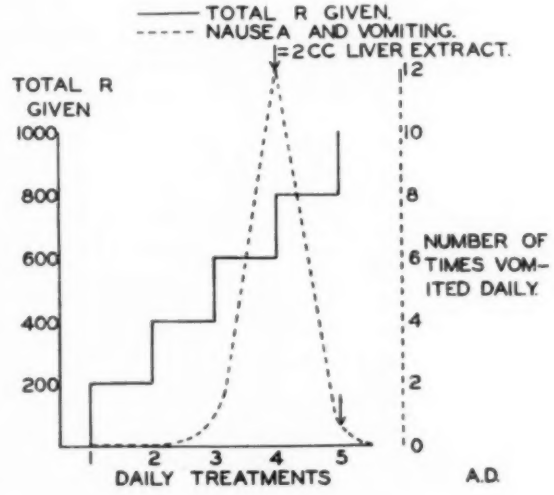

Fig. 3. One dose of liver extract stopped vomiting while second stopped residual nausea. (Persistence of nausea shown by tail of curve after last attack of vomiting.) A circular area 30 cm. in diameter over the front and back of the abdomen was treated daily. Patient had previously received much irradiation for metastatic carcinoma of the skeleton.

administration of the liver extract if the roentgen treatment series lasted only a day or two after cessation of nausea and

vomiting. In order to determine the length of time that certain patients would stay symptom-free (after the nausea and vomiting had been controlled), we withheld the extract but continued the daily doses of roentgen rays. This experiment was tried on 3 patients. The first of these (C. G.) developed roentgen sickness during the second series after three daily treatments had been given to the front and back of the abdomen. Two cubic centimeters of liver extract stopped all nausea and vomiting. No more liver extract was given, but daily roentgen treatments were continued for two days when once more nausea and vomiting became a distressing complication. Again liver extract gave the patient immediate relief. The second patient (A. H.) became quite ill after twenty-four roentgen treatments had been given to the breast and supraclavicular region. The vomiting ceased after one dose of liver and the second dose resulted in the disappearance of all symptoms. The daily roentgen treatments were continued for three days without liver extract but the following day it was necessary to start the injections once more. The history of the third patient (V. H.) is much like the other two in that the day prior to institution of liver therapy she vomited twelve to fifteen times. Complete relief was obtained after 2 c.c. of liver extract but she stayed well only one day (see Table I).

Liver extract produces an additional beneficial effect in that roentgen intoxication is partially or wholly relieved by its use. Listlessness, lack of interest in life, depression, loss of energy and appetite are the principal features of this malady. It is interesting to learn of the disappearance of these symptoms soon after the institution of the liver extract. We cannot offer any scientific proof or advance any reason for this effect but we are at present carrying out experimentation on animals in the hope that valuable information will be gained. It is also significant that similar observations have been made by other workers, notably by Murphy[4] and Quick.[5]

Of the total of 30 patients, 16, or 53 per cent, were completely relieved by one or more doses of liver extract; 7, or 23 per cent, were relieved of all vomiting but they complained at some time during the treatment series of nausea; 7 were classified as failures. Twenty-three of the 30 patients, or 77 per cent, were either completely or partially relieved by the drug. Of the 7 patients who did not respond to the liver extract, 6 received daily treatments to the abdomen; 4 of these received daily doses of 200 r or more to the front and back of the cephalic half of the abdomen and caudal part of the chest, the beam being centered so that the liver and stomach were at least partly irradiated. The fifth was given sixteen daily treatments of 50 r each to the lateral aspect of the spleen while the sixth received 200 r to the front and back of the abdomen and pelvis daily for five days. The seventh patient was treated for carcinoma of the larynx after the method of Coutard. In this case relief was obtained following the third injection of liver extract to the extent that she complained only of slight nausea but from this time until the series was completed liver extract produced no beneficial effect. For further details of this group see Table III.

SUMMARY AND CONCLUSIONS

Results of administration of liver extract in 30 cases of roentgen sickness are reported in tabular form, with comments. In 53 per cent of our 30 cases, results were spectacular and the remedy appeared to be specific. In an additional 23 per cent good, but less spectacular, benefits were obtained; 23 per cent were regarded as failures.

In our opinion, liver therapy should be used routinely for roentgen sickness. No harmful effects have been noted. In some cases the administration of liver extract permits the radiologist to employ larger areas and larger total doses than could be used without liver therapy.

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DISCUSSION

Dr. John T. Murphy, Toledo, Ohio. I am glad Dr. Young discussed the use of liver extract at this meeting. During the course of the last two or three days, we have heard a lot of machine details and outputs but no one has said anything about the treatment of the patient himself.

The use of liver was called to my attention some years ago by Dr. Douglas Quick, who has used it for several years. We started to use it with the idea of controlling the nausea and vomiting. We never give more than 210 r per day, and only to one field so that the amount of nausea and vomiting is very light. The general condition of the patient during protracted irradiation, which may extend over three months, even though roentgen sickness is not present, must be carefully watched. We now almost routinely give liver extract to these patients. I do not give as large a dose as Dr. Young does. We have found with our method of treatment, if we give the average patient 1 c.c. intramuscularly three times a week, we are able to keep the patient fairly comfortable.

We have not used the intravenous method; there are, however, some individuals who will not take the liver extract because of the muscular reactions, and pain afterwards. It will have no effect on the patient who gets roentgen sickness from nervousness. However, I think it is important and I can heartily recommend it to sustain the patients during long treatments. Give them routine liver injections. We have tried the oral method with a combination of liver extract and iron, but the intramuscular method is so much easier that we use it routinely.

Dr. Young (closing). I want to thank Dr. Murphy for his discussion of the paper. During the early months of the work several patients complained bitterly of soreness from intramuscular injection. Since that time our method of giving the drug intramuscularly has been completely changed. We adopted the technique and site of injection utilized by the syphilologist, with excellent results, and for some time we have had no complaints.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: Lawrence Reynolds, M.D.
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Thirty-seventh Annual Meeting: Cleveland, Ohio, Sept. 29-Oct. 2, 1936.

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Twenty-first Annual Meeting: Kansas City, Mo., May 11-12, 1936

EDITORIAL

PYOGENIC OSTEOMYELITIS OF THE SPINE

OSTEOMYELITIS is a protean disease. It manifests itself in various forms and offers at times considerable difficulty in diagnosis, particularly osteomyelitis of the spine which is considered a relatively uncommon disease, though numerous reports and descriptions have appeared from time to time. The more recent report by Kulowski[1] who made an analysis and gave a discussion of 102 cases of pyogenic osteomyelitis of the spine, calls attention again to the relative frequency of the disease and to the fact that pyogenic osteomyelitis of the spine differs from other more common localizations of the disease chiefly because of its relatively vulnerable anatomical situation, and that the primary lesion therefore is often overlooked or is subordinated to the more extensive secondary purulent infiltrations in the adjacent vital organs and body cavities which are characteristic of the disease.

The group of cases which Kulowski reported from the University Hospital of Iowa State University included 60 instances of pyogenic spondylitis observed in that Hospital and 42 additional cases obtained by questionnaire. He says that the total number of cases reported in the literature, including his group, is well over 300. This relatively small number of reported cases, however, hardly gives an indication of the frequency of osteomyelitis of the spine as many roentgenologists can recall having examined a septic patient in whom the etiological picture of the sepsis was undetermined, and after making a thorough study of the usual sites for sepsis, were often quite chagrined to find at autopsy that they had overlooked a primary lesion in the spine.

Kulowski points out the fact that, contrary to early belief, pyogenic spondylitis is especially a disease of the vertebral bodies and their contiguous discs and that it seems to have a predilection for the lumbar region, although in his series of cases at the University Hospital the dorsal portion of the spine was frequently involved. The predilection for the vertebral bodies as noted in his investigation, he says, may be accounted for by the fact that the surgeon is now better able to discriminate between pyogenic spondylitis and tuberculosis and because the heaviest and largest vertebrae are in the lumbar region. Pyogenic spondylitis is almost always a diffuse lesion and more than one spinal segment is, as a rule, affected, at least in the later stages of the disease. This is easily accounted for when one considers the anatomical and architectural continuity of the cancellous structure in the body and posterior portions of the vertebrae. The lesions, as a rule, are irregular in shape and size and their limitation is determined by the vascular collateral circulation. Kulowski shows that extension to contiguous disc and vertebral body is further aided by the absence of the circumferential cartilage plate and the lack of the definite protective subchondral layer of compact bone as seen in normal joints. He calls attention also to the fact that the nature of the spongy bone and the peculiarities of the blood supply tend to develop a carious form of destructive necrosis and that condensation, proliferation and bone production are encouraged by the natural sluggishness of the vascular current in the vertebral bodies. "Characteristically, direct infections cause an ulcerative surface lesion of the body, whose depth depends upon the nature of the infectious agent and its duration. The type of lesion in the hematogenous forms is variable and may be destructive and ulcerative, solitary, and

[1] Kulowski, Jacob. Pyogenic osteomyelitis of the spine. *J. Bone & Joint Surg.*, April, 1936, *18*, 343–364.

localized, primarily in the disc alone, in the disc and the contiguous bony structures, or even in the subperiosteal area." The primary focus is usually in the bone marrow or in the disc and extension of the lesion may occur also by erosion anteriorly under the longitudinal ligament. Rapid invasion of the entire spongiosa may occur with subsequent collapse of the vertebra. Kulowski says that the limited pathological material and the roentgenographic studies in his series show that the disease may occur primarily in the posterior intervertebral joints or facets but pyogenic osteomyelitis in general is characterized by its variable pathological manifestations and spinal localizations offering no exceptions to this rule, except possibly for the early and persistent attempts at regeneration that go hand in hand with even the most rapid destructive elements of the disease.

As might be expected, the most common and probably the most important complication is suppuration and abscess formation, and too frequently the examiner is content with the demonstration of the abscess formation without searching for the original focus which may be a small localized area in the vertebral body or its pedicles or laminae.

In contradistinction to the slowly developing insidious symptoms of compression due to tuberculosis, pyogenic infection of the spine may be a very rapid process, and gibbosity which is so common in tuberculosis is relatively infrequent in pyogenic osteomyelitis of the spine because of the rapid extensive bone destruction that takes place in this disease. However, one diagnostic point is noted in almost all cases, namely, that there is some spinal deviation such as a mild scoliosis and loss of the normal physiological curves of the spine due either to limited destructive lesions or changes in the intervertebral discs or muscle spasm. As in most septic diseases, the prognosis depends upon a reasonably early diagnosis and adequate treatment, and Kulowski says that the most important requisite for clinical diagnosis of pyogenic spondylitis is a knowledge of the disease. Since the roentgen examination plays such an important part in the diagnosis it necessarily follows that roentgenologists should be familiar with the clinical manifestations of the disease process as well as its roentgenological appearances. Pyogenic spondylitis may be differentiated from tuberculous forms chiefly by the increased density, bony bridges and exostoses which characteristically occur in the former, and soft tissue paravertebral shadows incident to the attendant edema may be evident as an early sign and sometimes simulate abscess formation. Any abnormalities in the intervertebral spaces, however slight, in suspected cases are important, and, as would be expected, the trabecular architecture of the affected vertebra becomes obscured in the early stages, and in all suspected cases the entire spine should be examined in both anteroposterior and lateral as well as oblique views. Kulowski points out that many of the most important and earliest roentgenological changes are noted in the anteroposterior views, particularly static deviations, parosteal calcification, localized destruction, vertebral body changes, alterations of the intervertebral spaces and proliferative changes of all kinds with varying degrees of bony bridging. He points out one important factor, namely, that because the calcium salts remain and help to localize the lesion in pyogenic bone conditions, atrophic changes do not appear early, as a rule.

As is characteristic of all disease processes a diagnosis may be made in pyogenic spondylitis if the disease is thought of at all and if the various clinical and roentgenological manifestations of the disease are kept in mind. The mortality in pyogenic osteomyelitis of the spine is exceedingly high and no doubt an explanation for this lies in the fact that the diagnosis is made at a late stage in the disease process. Than the roentgenologist may be of considerable aid in making an earlier diagnosis is evident from the fact that probably in no disease is he so frequently called upon as in pyogenic infections, and in some of the more difficult cases where the diagnosis is obscure, the possibility of a pyogenic spondylitis as the causative factor should not be overlooked.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa. Annual Meeting: Cleveland, Ohio, Sept. 29–Oct. 2, 1936.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. B. H. Orndoff, 2561 N. Clark Street, Chicago, Ill. Annual meeting: Kansas City, Mo., 1936.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Kansas City, Mo., May 11–15, 1936.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y. Annual meeting: Cincinnati, Ohio, Nov 30–Dec. 4, 1936.

RADIOLOGICAL SECTION, BALTIMORE CITY MEDICAL SOCIETY
Secretary, Dr. W. B. Firor, 1100 N. Charles St., Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT STATE MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets annually in May. Special meetings may be called by the Chairman.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, E. N. Liljedahl, Los Angeles, Calif. Meets on the second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas. Annual meeting, Baltimore, Md., Nov. 17–20, 1936.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. E. Mendelson, 120 E. 19th St., Brooklyn, N. Y. Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. G. Willy, 1138 N. Leavitt. Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. H. G. Reineke, General Hospital Cincinnati, Ohio. Meets third Monday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, North W. Shetter, M.D., 14600 Detroit Ave. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. K. D. A. Allen, 452 Metropolitan Building, Denver, Colorado. Meets on any month having a fifth Monday.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Gerard Raap, Miami, Florida. Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Cesare Gianturco, 602 W. University Ave., Urbana, Ill. Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind. Meeting held the second Sunday in May annually.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. M. Dannenberg, 1464 Eastern Parkway, Brooklyn, N. Y. Meets on third Thursday of each month from October to May, at 8:30 P.M.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. C. S. Davenport, St. Lawrence Hospital, Lansing, Mich. Three meetings a year, Fall, Winter, and Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. S. A. Morton, Columbia Hospital, Milwaukee, Wis. Meets monthly. Place of meeting designed by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn. Meets in St. Paul, Minn., in March, 1936.

NEBRASKA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday evening of each month.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. P. S. Avery, New Brunswick, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by the president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. E. F. Merrill, 30 W. 59th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse, N. Y. Three meetings a year—January, May, and November.

PACIFIC ROENTGEN CLUB
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. L. E. Wurster, Williamsport, Pa. Next annual meeting June 5 and 6, 1936, Lycoming Hotel, Williamsport, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas Loughery, Germantown Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave. Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

ST. LOUIS ROENTGEN RAY SOCIETY
Secretary, Dr. P. C. Schnoebelen, Missouri Bldg., St. Louis, Mo. Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston Meets at time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary-Treasurer, Dr. J. H. Smith, Lubbock, Texas
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Department of Roentgenology Staff Meeting
Secretary, Dr. C. B. Peirce, University Hospital, Ann Arbor, Mich.
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Roentgen Club
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P.M.

Virginia Roentgen Ray Club
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Sociedad Española de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11.52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Süd- und Westdeutsche Röntgengesellschaft
Meets annually in different cities.

Nord- und Ostdeutsche Röntgengesellschaft
Meets annually in different cities.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. G. Gatoschi, Str. Isvor 14–16, Bucarest.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

Society of Medical Radiology in Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Roentgen Society
Meets first Wednesday of each month, at 6.30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

REPORT OF THE COMMITTEE ON LEGISLATURE AND PUBLIC POLICY OF THE AMERICAN ROENTGEN RAY SOCIETY

During the past year a significant step has been taken by the A. M. A. to clarify the relation of the radiologist to the Hospital. The A. M. A. has announced as an ethical principle that the hospital may not exploit the services of the radiologist for financial profit to the hospital.

A resolution from the Section of Radiology of the A. M. A. was referred to the Council on Medical Education and Hospital. The report of the Council on that resolution was revised by the House of Delegates in June and adopted. By that action position of the A. M. A. is now defined by the House of Delegates to read as follows:

That no single method of compensating the radiologist for his services is universally applicable; that without violating the principles of Medical Ethics of the Association his remuneration may be in the form of salary, fees or commissions or any combination of these; but that in no case shall an economic arrangement be operative which is designed to provide a direct profit to the institution from private patients.

The accepted report of the Council on Medical Education and Hospitals continues as follows:

While these principles have been clearly and repeatedly affirmed by the House of Delegates, the applications of the principles to individual cases sometimes involves complex accounting problems. It is believed that where differences of opinion arise they should be adjudicated by the local medical societies.

Having adopted this principle of non-exploitation of the radiologist another important action of the House of Delegates may help to enforce this position. The following recommendation of the Reference Committee on report of officers was adopted:

Your committee therefore recommends that the Council on Medical Education and Hospitals, together with the Judicial Council, formulate a plan whereby all those associated in the delivery of medical service be included in an investigation of hospitals for classification and that approval be based in the future on the ethical practice of the institution as well as on its scientific work.

These two actions of the A. M. A. in June if carried to their logical conclusions will be the foundation of adjusting the difficult problems confronting the radiologist in the hospital. This is only one step toward the solution of the problem but it is fundamental and it is significant that the problem has been recognized by the A. M. A. and its Council on Medical Education and Hospitals. The further development of the Hospital situation is one of the prime functions of organized radiology in the immediate future.

Your committee on Legislature and Public Policy makes the following recommendation to the Executive Council:

1. That the manufacturers be encouraged to present the results of research in apparatus and technique on the scientific program and in the scientific exhibits, and that this society thus take official recognition of this technical progress.

2. That the American Roentgen Ray Society in its public policy establish intimate contact with the Radiological Society of North America, the Radium Society, the Section on Radiology of the American Medical Association and the College of Radiology to the end that the Radiologists in America may present a united front. It is most important that there be no question from organized medicine or from the hospital association concerning the uniformity of purpose or the undivided judgment in considered demands made by organized radiology.

3. That the Committee on Public Policy develop the closest possible contact with the Council on Medical Education and Hospitals and with the Bureau of Legal Medicine of the A. M. A. and seek their cooperation. The future of Radiology will depend largely on the mutual understanding and active cooperation with the A. M. A.

W. EDWARD CHAMBERLAIN
L. R. SANTE
LYELL C. KINNEY

RESOLUTIONS PRESENTED BY THE COMMITTEE ON LEGISLATURE AND PUBLIC POLICY OF THE AMERICAN ROENTGEN RAY SOCIETY

RESOLUTIONS REGARDING SCHOOL TUBERCULOSIS SURVEY

WHEREAS, The American Roentgen Ray Society realizes the need for, and the value of, early tuberculosis surveys among school children as a public health measure, and

WHEREAS, Such surveys accurately conducted discover contacts and permit breaking of contacts that endanger the growing child, and

WHEREAS, The accurate x-ray examination of positive reactors is a necessary and important part in the diagnosis of clinical tuberculosis, and

WHEREAS, Such x-ray examinations are only of value when made by a competent roentgenologist and involve individualization as to technique and repetition of studies, and

WHEREAS, Examinations of positive reactors by mass production methods only detect gross advanced lesions and lead to inaccurate and misleading interpretation, and

WHEREAS, Photographic paper is inferior to celluloid films in the proper interpretation of early tuberculous lesions, therefore be it

RESOLVED, By the American Roentgen Ray Society that the members of this Society be encouraged to actively cooperate with the local state and county tuberculosis associations.

(1) In making existing facilities of hospitals and private x-ray departments available for such school surveys.

(2) In making such reasonable arrangements with local tuberculosis societies that will encourage adequate accurate x-ray examinations of positive reactors as a public health measure, and be it

RESOLVED, That the American Roentgen Ray Society disapprove and condemn routine x-ray examinations by mass production methods; and further be it

RESOLVED, That the American Roentgen Ray Society disapprove of photographic paper in x-ray examinations of the chest.

RESOLUTION CONCERNING DISTRIBUTION OF FEE SCHEDULES

WHEREAS, It is the practice of some physicians, particularly pathologists and radiologists, to publish and circulate fee tables and schedules of prices, and

WHEREAS, Such fee tables and schedules may with propriety be furnished to patrons and clientele upon their request for their information, and

WHEREAS, The indiscriminate circulation of such fee tables or schedules partakes of the nature of advertising and the solicitation of patients on a basis of price rather than on the quality of service and further invites price cutting competition, therefore be it

RESOLVED, The American Roentgen Ray Society declares the indiscriminate distribution of fee tables and schedules of prices to be unethical.

RESOLUTION CONCERNING HOSPITAL ADVERTISING

WHEREAS, Certain Hospitals and Clinics throughout the country are circulating objectionable publicity concerning the institution and the medical staff, which publicity is in violation of the proper ethical and professional restrictions placed upon individual physicians, and

WHEREAS, The House of Delegates of the American Medical Association has made a definite declaration of policy in this regard in 1924 and has reaffirmed and re-emphasized this policy in 1934 as follows:

"1. Publicity by clinics, hospitals, sanatoriums and other semi-public medical institutions as to quality of work done implies unusual and exceptional ability and efficiency on the part of their professional staffs and therefore is advertising of the medical men concerned. This type of advertising distinctly savors of quackery and is unethical.

2. Publicity by any such institution stating or implying that by reason of its exceptionally fine equipment and material resources, it is able to, or does, give the public better medical service than similar institutions are able or willing to render, is advertising for purposes of self aggrandizement. Statements of this type are frequently exaggerated and misleading, and are detrimental to the best interests of the public, of the institution concerned and the medical progress. Publicity of this kind is unethical." and

WHEREAS, The American Roentgen Ray Society is in full accord with this statement of policy of the American Medical Association, therefore be it

RESOLVED, That the American Roentgen Ray Society approve and support the above declaration of policy of the American Medical Association and that said declaration be adopted as a statement of policy and principle of this Society.

W. EDWARD CHAMBERLAIN
L. R. SANTE
LYELL C. KINNEY

HOMAGE TO DOCTEUR ANTOINE BÉCLÈRE

The friends and pupils of Dr. Antoine Béclère celebrated the eightieth anniversary of his birth, March 17, 1936. On this occasion they presented him with a medal stamped with his image and a jubilee book containing a résumé of all his scientific work. The Journal wishes to add its expression of respect and admiration for the great life and work of Dr. Béclère, and its readers will be interested in securing either the medal or both the medal and the jubilee book. A slip to be filled out and mailed will be found elsewhere in the Journal.

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DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., M.S., 105 Rutledge Ave., Charleston, S. C.

PROGRESS IN ROENTGEN DIAGNOSIS WITH THE AID OF THE LYSHOLM GRID

By MAX COHN, M.D.

From the Department of Roentgenology, Mount Sinai Hospital

CHICAGO, ILLINOIS

IT IS a peculiarity of the penetrating power of the roentgen rays that when they pass through the body secondary rays arise which cloud the picture. Ever since the invention of Albers-Schönberg's compression tube it has been the chief aim of roentgenologists to eliminate this fault as far as possible. Bucky was the first to eliminate the secondary rays by placing a grid between patient and film. Potter accomplished the Bucky effect excellently without the disturbing pattern of the grid on the film, by making the grid movable.

It is interesting that the latest development of the grid—that by Lysholm of Sweden—utilizes the immovable form. The new grid does not replace the Potter-Bucky diaphragm but is an excellent supplement, offering new possibilities in diagnosis. The Potter-Bucky grid gives faultless results when used horizontally, but the weight of this grid is considerable and its use outside the roentgen department is therefore limited. The Lysholm grid has the advantage of small weight which permits its use above the patient as well as vertically.

Elimination of the secondary rays by a grid depends on the height of the lead strips, their thickness, and the distance of the strips from each other. Lysholm made the lead strips as thin as possible and shortened their height to a few millimeters. These strips of lead must be supported if they are to be kept in position. This is done by pressing the grid system together with the help of a modeling clay. The chief difficulty in this task, to attain uniformity of pressure by means of a machine, has now been overcome. A roentgenogram of the grid shows the strips as a pattern of fine lines, and the modeling clay is not visible. It would seem that the grid pattern on the roentgenogram must be annoying,

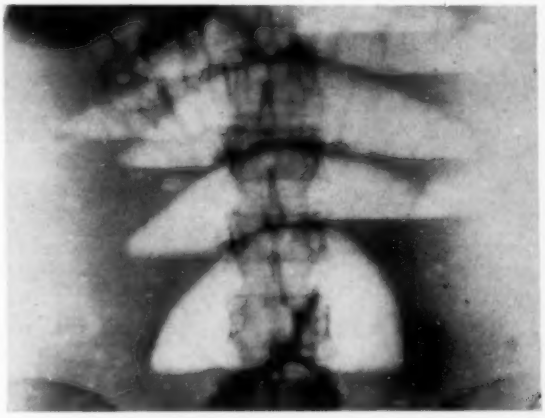

Fig. 1. Anteroposterior view of the abdomen in upright position taken with the Lysholm grid. A number of horizontal fluid levels with air above in the upper loop are seen. The pattern of the small intestine is well visible. There is no fluid air pattern of the colon; consequently the diagnosis is ileus of the small intestines.

but this is not the case. The lead lines are reduced in sharpness to such a degree by the distance from the film that they are hardly noticeable, and at the same time the elimination of the secondary rays is accomplished. A few illustrative cases follow.

It is well known how difficult it is to take a good roentgenogram of the hip at the bedside of the patient. The image is dim and one must often be content if he is able

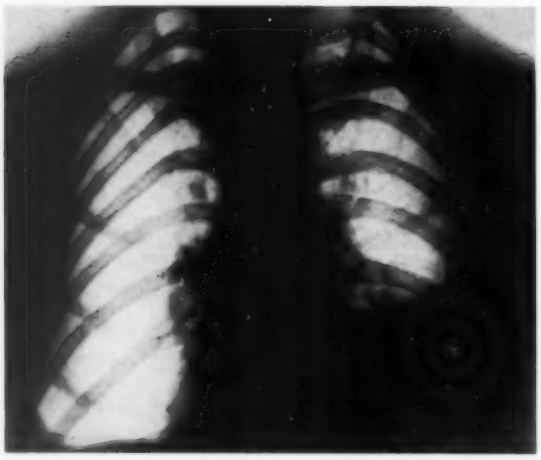

Fig. 2. Posteroanterior view of the thorax. Large effusion on the left side, small effusion on the right side. The shadow of the aorta is of homogeneous density.

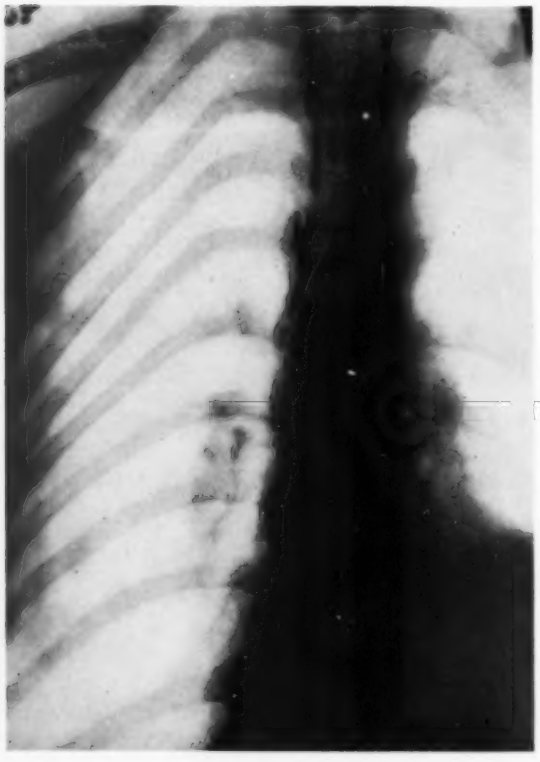

Fig. 3. Anteroposterior view of the thorax taken with the Lysholm grid showing a small lead marker at the site of the stab wounds. Above it there is a shadow to the right of the spine corresponding to the broken blade.

to recognize the lines of the fracture. While it is usually preferable to transport the patient to the roentgen department and to take a film there using the Potter-Bucky diaphragm, the condition of the patient or the presence of traction appliances may prevent his being moved. By use of the Lysholm grid, a satisfactory view of the hip is obtained, to the great advantage of the doctor and the patient.

Fig. 4. Lateral view of the thorax taken with the Lysholm grid shows the broken blade in its entire length.

Roentgen examinations with the Lysholm grid taken with the patient upright in cases of ileus are especially instructive. The decomposition of the intestinal contents shows a constant level formation with gas bubbles above it. This diagnosis can only be made in a vertical position, because in the vertical position fluid and air are not superimposed. The roentgenogram shows a number of strongly inflated loops of the small intestine with fluid levels and

next to them a number of intestinal loops but slightly inflated. The large intestine being collapsed is not visible (Fig. 1).

Roentgenograms of the lungs are universally made without a grid diaphragm. And yet even here the Lysholm grid is sometimes of immeasurable value. For instance, a man was stabbed; while he was lying on the ground, his assailant gave him additional stabs in his back. The victim managed to drag himself as far as the hospital where it was found he had several wounds in his back. The normal roentgen examination showed a double-sided pleuritic exudate (Fig.2). Puncture showed pure blood in the pleural cavity. The diagnosis should have been lesion of the pleura on both sides as the result of stabbing. As we had noted advantages from the use of the Lysholm grid in other cases when examining the dense parts of the thorax, additional roentgenograms with the Lysholm grid were made. The largest wound was marked by a lead marker. Now on the ventrodorsal roentgenogram was seen a longitudinal metal shadow which might correspond to a knife blade struck orthogradely (Fig. 3). Then a roentgenogram was made in the lateral view (Fig. 4). Now the blade could be seen in full length; it had broken off exactly at the hilt. The mechanism of the injury occasioned by the assailant stabbing his victim when lying on the ground was obviously better explained. It was astonishing that the wounded man had no idea what had happened to him; he had neither noticed the breaking of the knife nor had he felt any pain. The operation was very simple. By a paravertebral incision and resection of the ribs, the spot where the knife had been broken off was exposed to view and the blade then drawn out with a pair of forceps.

I hope to have shown that this new method avoiding secondary radiation gives excellent results. The Lysholm grid does not replace the movable grid of Potter-Bucky but it is an excellent help in examinations in which the change in position plays an important part. We are only beginning to use it but I am sure we shall be able to solve other problems with it.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Chorobski, Jerzy, and Davis, Loyal. Cyst formations of the skull. *Surg., Gynec. & Obst.*, Jan., 1934, *58*, 12–31.

When blood, usually as a result of trauma, collects between the pericranium and the skull the condition is termed cephalhematoma. It is usually seen in infancy as a result of injury during labor. Fissures of the bone, minute linear fractures, often accompany the blood extravasation. The third day after delivery is when cephalhematomata most frequently occur. The most frequent site of the effusion is the right parietal bone. They may be single or multiple and are limited by the sutures. The swelling is usually absorbed in from two weeks to three months, although it may persist throughout life. If absorption has not occurred in two weeks, Cushing advises incision and evacuation of the clot. The swelling may become surrounded by a ridge of new-formed bone, deposited along the elevated pericranial edge. Bone salts are sometimes deposited in the elevated pericranium. If swelling persists in a cephalhematoma there may occur absorption of the underlying bone.

The incidence of cephalhematomata is between 1 in 20,402 deliveries (Beck) and 1 in every 166 deliveries (Hofmckl).

The authors review the literature most comprehensively and discuss the diagnosis of other cystic conditions of the skull, such as solitary bone cysts, osteitis fibrosa cystica, giant cell tumors of the skull and hemangiomata.—*J. H. Vastine.*

NECK AND CHEST

Bianchini, Alessandro. Lo studio radiologico della mammella muliebre. (The roentgen study of the female breast.) *Radiol. med.*, Feb., 1935, *22*, 167–172.

The author describes and illustrates his method of studying the female breast. The patient lies on the table slightly inclined toward the side to be examined with the opposite side of her body slightly raised and supported by wedge-shaped cushions. Her arm is thrown up over her head. A little wooden stool with a curved surface adapted to the outline of the breast, the anterior wall of the thorax and the axilla is used to support the breast, the other breast being held to the opposite side by the patient's hand or by adhesive tape. He does not use an antidiffusor or a reinforcing screen. The tube is at a distance of a meter or more from the breast and its normal ray passes through the base of the breast tangent to the anteroexternal wall of the thorax. Respiration should be arrested during the exposure time of two to five seconds. Rays of 40–60 kv. are used.

The method is valuable in making a differential diagnosis between early malignancy and mastitis. In the latter the architecture of the breast is not destroyed while in the former it is. In order to make the differentiation, however, it is necessary for the examiner to be thoroughly familiar with the picture of the normal female breast in all its different phases of functional and sexual activity. Long experience in the study of normal cases is a necessary preliminary to effective use of the method in differential diagnosis.—*Audrey G. Morgan.*

Jackson, Chevalier. Carcinoma and sarcoma of the esophagus. *South. Surgeon*, March, 1935, *4*, 1–11.

Diagnostic methods mentioned in textbooks enumerate signs that are always negative in the early stages of esophageal malignancy. The roentgen ray and the esophagoscope are the only worthwhile diagnostic agents. The roentgen examination should precede esophagoscopy and diagnosis by this means was correct in 85–90 per cent of the author's cases. However, it is not conclusive and final; esophagoscopy should be performed for an absolutely certain diagnosis. Esophagoscopic findings, pathology, prognosis and treatment of the lesions are discussed.—*W. R. Brooksher.*

Vinson, Porter P., and Weber, Harry M. The localization of bones in the esophagus by roentgenoscopy. *Minnesota Med.*, April, 1935, *18*, 240–242.

Foreign bodies in the esophagus such as fish or meat bones are rarely demonstrated by

roentgen examination. The authors suggest that esophagoscopy precede roentgen examination in these cases unless direct roentgen examination reveals the foreign body. Additional procedures such as the ingestion of small amounts of barium may so coat the esophagus as to prevent visualization of the fragment by the esophagoscope.—*W. R. Brooksher.*

Blasi, Raffaele. Contributo alla patologia del lobo azigos ed alla interpretazione delle doppie strie. (Pathology of the azygos lobe and interpretation of the double stripe.) *Radiol. med.*, April, 1935, *22*, 312–325.

The author classifies pathological conditions of the azygos lobe into three groups: those affecting only the parenchyma of the abnormal lobe, those affecting only the interlobar folds of pleura and those affecting both the parenchyma and the pleura. He subdivides these into primary and secondary, specific and nonspecific.

He then describes 3 cases of azygos lobe which are illustrated with roentgenograms. In the first there was a double line marking the meso-azygos which as a result of a pathological condition was reduced to a single line which he could not modify by changes of projection. In the second case there was a double meso-azygos which he was able to reduce by changing the incidence of the rays to a single line which however was heavier than the normal line. In the third case the meso-azygos was a heavy stripe which he could not divide into two by any change of incidence.

He concludes therefore that double lines marking the meso-azygos are not simply effects of projection. It is a pathological symptom, an evidence perhaps of an effusion into the meso, which detaches and thickens the four pleural folds which normally only give a single capillary line. This theory is confirmed by the fact that the two lines do not always have the usual subcapillary appearance and that it is not always possible to separate a single line into two.—*Audrey G. Morgan.*

Battigelli, Giacomo. Forma gigante di tubercolosi dei gangli tracheo-bronchiali in un adulto. (Gigantic form of tuberculosis of the tracheobronchial glands in an adult.) *Radiol. med.*, Feb., 1935, *22*, 173–181.

The author describes a case which he thinks interesting on account of its rarity. The patient was a young woman nineteen years of age who had lived in a tuberculous family; she came for examination for asthenia, loss of appetite and loss of weight. She had never had cough, catarrh or fever. Roentgen examination showed enormous enlargement and calcification of the tracheobronchial lymph glands. Examination fourteen months later showed practically the same clinical condition and the same roentgen picture except that the gland shadows were somewhat larger.

The unusual point about this case is that this tumorous form of involvement of the tracheobronchial glands is rarely seen in adults. It is a form of tuberculosis generally seen only in young infants and it generally ends in miliary tuberculosis and death. This case was not only in an adult but its course was chronic; the enlargement of the glands had evidently existed for some time as they were calcified and in the fourteen months of observation there was little change in the clinical or roentgen condition.—*Audrey G. Morgan.*

Ruckensteiner, E., and Hörtnagl, H. Über einen seltenen Fall von offener Waberlunge. (A rare case of open cystic lung.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1934, *50*, 571–577.

In the authors' case, which had very mild symptoms, the whole left lung was replaced by large thin-walled cysts which were under pressure and which greatly diminished the air space. Puncture and aspiration of the cysts demonstrated that the pleural space was largely free with corresponding changes in pressure. The lesion is thought to be of congenital origin.—*E. T. Leddy.*

Nicotra, Antonino. Rilievi anatomo-radiologico sul polmone cistico congenito. Contributo alla sistematizzazione delle malformazioni del polmone. (Anatomical and roentgen study of congenital cystic lung. Contribution to a classification of malformations of the lung.) *Radiol. med.*, 1935, *22*, 238–257.

Three cases of congenital cystic lung are described and illustrated with roentgenograms. Two of them involved an entire lung, in one case the right and in the other the left, while the other involved only the lower lobe of the left lung. In connection with these cases, the author discusses the classification of cystic lesions of the lungs, dividing them into three

groups: congenital cystic lung, bronchiectases and subpleural cysts. Congenital cystic lung is what he calls an integral anomaly of a "respiratory unit," that is, it affects both the bronchi and alveolar tissue of a whole lung or a whole lobe, while bronchiectases are malformations limited to the bronchi and subpleural cysts affect only the alveolar tissue.—*Audrey G. Morgan.*

VALLEBONA, ALESSANDRO. Il quadro radiologico delle bronchiectasie. (The roentgen picture of bronchiectases.) *Radiol. med.*, April, 1935, *22*, 329–361.

This was a lecture given before the Italian Medical Society and consisted largely of the demonstration of roentgenograms of cases of bronchiectasis illustrating different types and phases of the disease taken by the different methods. The author discusses simple roentgenography without contrast, bronchography with contrast and stratigraphy. The latter is a new method in which a single layer is brought out and the other layers of tissue eliminated. This does away with superpositions and gives a very clear picture of the layer to be examined. The author compares it to reading a single page of a book as compared with trying to read the picture of all the pages superimposed. It is accomplished by making a slight movement of rotation while the roentgenogram is being taken around an axis consisting either of the patient or of a rigid system including the tube and film.

Bronchography has been so much improved and the pictures found compared so carefully with those taken by simple roentgenography that the latter method can now be used in many cases in which it could not be used formerly, thus dispensing with the necessity of giving contrast. There are two fundamental and contradictory appearances in the picture of bronchiectasis: increased clearness from enlargement of the lumina of the bronchi and decreased clearness, or rather increased opacity from liquid in the bronchiectatic cavities, thickening of the walls of the bronchi or inflammation of the superimposed lungs and pleura. The most typical picture in uncomplicated bronchiectasis is that of intersecting rings; sometimes instead of being round the cavities are facetted giving a reticulate picture with meshes of varying sizes. Bronchiectases may be complicated with various pulmonary or pleural processes and it may be necessary to differentiate them from congenital cysts, bullous emphysema or tuberculous cavities. These various conditions are illustrated with roentgenograms.—*Audrey G. Morgan.*

NEUHAUS, W. Beobachtung bei Bronchiektasen. (Some observations on bronchiectasis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1934, *50*, 569–571.

In the author's case a spherical shadow in the right lower lobe the size of the hand was observed which on coughing became less dense but extended upwards for a greater extent and which after coughing reassumed its original size and shape. It seemed as if fluid were expelled from the upper portion of the lung into this shadow. It was assumed by Neuhaus that the case was one of bronchiectasis with the cavities filled with effusion.—*E. T. Leddy.*

SCHAPIRO, I. SCOTTY, and JACHES, LEOPOLD. Bronchography and bronchiectasis. *N. York State J. M.*, April 15, 1935, *35*, 441–447.

Bronchography is of distinct value to determine the pathological lesion present and to precisely locate it to a bronchus and its corresponding pulmonary segment. Diseases of the bronchi as demonstrated clinically and bronchographically are discussed under four headings: (1) those with cylindrical dilatations and varicosities, clinically composed of cases of chronic bronchitis usually associated with chronic sinusitis; (2) those with more extensive damage to the walls developing in the course of a severe bronchopneumonia; (3) those with the classical picture of advanced bronchiectasis, and (4) those where bronchiectasis develops as a complication of a specific condition in the chest, such as lung abscess or tuberculosis.—*W. R. Brooksher.*

JOHNS, E. P., and SHARPE, W. C. Primary pulmonary sarcoma. *Am. J. Cancer*, Jan., 1935, *23*, 45–51.

A case of primary pulmonary sarcoma in an eighteen year old male is reported. Death resulted eighteen months after onset of symptoms. At autopsy the tumor was found to have invaded the lumen of the bronchus and to have extended along the pulmonary vein to the auricle. The authors discuss briefly the mesodermal origin of the septal cells and suggest these cells as a possible origin for the tumor. They believe in the common origin of pul-

monary sarcomas and that later differentiation of the cells determines the classification.—*J. H. Harris.*

Heeren, J. Röntgendiagnose verkalkter Herzthromben. (The roentgen diagnosis of calcified cardiac thrombi.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1934, *50*, 490–500.

The author describes a large calcified thrombus of the left auricle with mitral disease which produced very mild clinical symptoms. Diagnosis was made by the roentgenogram. Heeren points out some other lesions that may give a similar roentgen picture and discusses their differential diagnosis.—*E. T. Leddy.*

Levine, Harold D. Cardiac hypertrophy in infancy, associated with thickened endocardium and coarctation of the aorta. *Am. J. Dis. Child.*, Nov., 1934, *48*, 1072–1079.

Levine reports a case of hypertrophy of the heart in a ten months old infant. The heart, weighing 150 gm., showed no valvular defects, but the endocardium of the left ventricle was uniformly and diffusely thickened and opaque. There was narrowing of the descending branches of the left coronary artery with partial coarctation of the aorta of the infantile type. No inflammatory reaction was seen in the heart.

From the pathologic standpoint the presence of coarctation and endocardial fibrosis immediately excluded this case from the category of "idiopathic" hypertrophy of the heart. In considering the etiology of the condition, Levine discusses the possibility of various factors which may cause cardiac hypertrophy, and other changes, such as developmental anomalies, mechanical factors, inflammatory processes, toxic influences, and lastly a combination of these factors. Thus, mechanical and inflammatory causes may have been operative together, as, for example, there may have been in his case parietal endocarditis which healed to form a thickened and fibrous endocardium, while the coarctation of the aorta (itself developmental or inflammatory in origin) by making a higher blood pressure, brought about myocardial hypertrophy. He mentions the theoretical possibility that all cases of cardiac hypertrophy with thickened endocardium in infants are not invariably fatal in infancy or childhood and that such cardiac defects seen in adults may have been acquired in infancy or before. By seeing only the fatal cases one perhaps gains a distorted idea of the malignancy of the condition.—*R. S. Bromer.*

Torelli, Gastone. Sul significato della stria capillare. (The significance of the capillary line.) *Radiol. med.*, April, 1935, *22*, 326–329.

There has been a great deal of discussion as to whether the capillary line represents a normal or a pathological incisure. The author examined 474 normal individuals and found a capillary line in 328, or 69.2 per cent; there was no capillary line in 146, or 30.8 per cent. The visibility varied with the technique used. The more perfect the technique the higher the percentage of visibility. He counted as positive all cases in which the line was seen in any roentgenogram. It did not appear in all the roentgenograms of all these individuals. but even among the cases negative with ordinary roentgenography, the line was found by means of serial roentgenography in 33 cases, by lateral projection in 21 and in 4 cases it was found only in the right retrocardiac lobe. Adding these cases to the former figure gives a total of 386 positive cases, or 81.5 per cent.

He concludes, therefore, that the line represents a normal incisure. The objection has been made that if that were true it would appear in all cases but the line is so delicate that it appears only in a certain incidence of the rays. It is visible only when the incisure is taken en enfilade for a certain distance.—*Audrey G. Morgan.*

Bloch, Giorgio, and Zanetti, Serse. Ricerche sperimentali sull'arteriografia polmonare. (Experimental study of pulmonary arteriography.) *Radiol. med.*, March, 1935, *22*, 267–272.

While angiography of other organs and regions of the body has been very successful that of the lungs has not been developed to a point where it is particularly useful in roentgen diagnosis. The authors held that this was because the contrast liquid has been introduced into the right heart and has been too much diluted before reaching the lung. They therefore devised a method of introducing the contrast medium directly into the pulmonary artery. A metal sound is introduced through the jugular vein into the right heart and a soft sound pushed through it into the pulmonary artery. Illustrations are given of the very clear roentgenograms obtained by this method. After they had mastered the technique thoroughly

they found that the animals bore the method perfectly and they hope to be able to try it in human cases.—*Audrey G. Morgan.*

VON DER WETH, G. Röntgenkymographie und Kollapstherapie bei Lungentuberkulose. (Roentgen kymography and collapse therapy for pulmonary tuberculosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, *50*, 428–441.

The author illustrates how a study of the roentgen kymogram may give valuable points of differentiation of intrapulmonary lesions which are of the greatest importance in outlining the correct method of collapse therapy to use for the treatment of pulmonary tuberculosis.—*E. T. Leddy.*

GYNECOLOGY AND OBSTETRICS

CLIFFORD, STEWART H. I. The x-ray measurement of the fetal head diameter *in utero*. *Surg., Gynec. & Obst.*, 1934, *58*, 727–736.

The author describes a technique of stereoroentgenometry by which it is possible to predict the size of the fetal head to within 0.3 cm. of the actual size in 97 per cent of the cases in which the fetal head occupies a favorable position for mensuration; 80 per cent of the vertex presentations and 50 per cent of the breech presentations were accurately measured at the first examination.

The author makes tracings from stereoroentgenograms and by means of the Johnson stereoroentgenometer locates the position in space actually occupied by the fetal head, by pointers and the measurements made. This appears to be an accurate method. The disadvantages are the possibility that the fetal head is not in a favorable position for mensuration, or that the fetal head has moved during or between the two eight second exposures. Many repeat films would make this a rather uneconomical method for routine use in ward and clinic cases which probably constitute a great majority of those in which measurements are requested. The method has not been found satisfactory thus far for pelvimetry.—*J. H. Vastine.*

GENITOURINARY SYSTEM

GESCHICKTER, CHARLES F., and WIDENHORN, HANS. Nephrogenic tumors. *Am. J. Cancer*, Nov., 1934, *22*, 620–658.

In this article a pathological and clinical analysis is made of some 200 cases of renal tumors seen at the Johns Hopkins Hospital. The study is limited to nephrogenic neoplasms arising in the cortex. These are (1) embryonal adenosarcoma of Wilms, (2) the malignant nephroma or so-called hypernephroma of Grawitz and (3) benign adenomas or papillary cystadenomas which occasionally undergo malignant degeneration.

Thirty-five cases of Wilms' tumor were studied. The most common symptom was a mass occupying the entire abdomen. Pain was seen in only 5 per cent. These tumors are to be differentiated from neuroblastoma of the adrenal of the Pepper type with metastasis to the liver, lymphosarcoma of the retroperitoneal nodes and carcinoma of the sex glands in females or in aberrant gonadal tissue in the male. The most helpful aids in diagnosis are pyelography, the Ascheim-Zondek test and a course of deep roentgen therapy.

The cases were divided into 3 groups according to the pathology noted: (1) the tumors elaborated from a very primitive mesodermal tissue at the site of the future nephrotome, (2) those in which primitive nephrogenic tissue predominates, and (3) the tumor resembling the growth zone of persisting embryonic nephrogenic tissue found beneath the capsule of the kidney in new born infants. These tumors are not teratomatous or mixed but represent a neoplastic exaggeration of the normal developmental processes occurring in the growth zones of the renal cortex in late fetal life or the first few months after birth.

Regardless of the type of treatment none of the patients lived beyond the five year period.

Of the 60 benign adenomas studied, only 5 gave symptoms during life. The majority were small and located immediately beneath the capsule. In the large tumors the diagnosis of malignancy is difficult to determine at times and all such tumors when causing symptoms are best treated by nephrectomy.

Twenty cases of malignant cystadenomas were studied. The clinical features were pain, hematuria and mass in the flank. Fever and bone metastasis were also present. The microscopic structure of these tumors resembles in general pattern the benign tubular adenomas. The prognosis is as grave as that of the hypernephroma. Treatment is nephrectomy with ureterectomy.

The most common tumor of the kidney occurs in adults past fifty and arises near the renal capsule in the cortical area of the kidney. They are characterized by early metastasis to

bone and by pain and enlargement in the flanks accompanied by hematuria. In view of the current opinion that these tumors arise from the epithelium of the renal tubules they have been described as papillary adenocarcinoma by Ewing and malignant nephromas by Young, these terms replacing the original designation of hypernephroma of Grawitz. The authors believe that all carcinomas of the kidney unless showing sex symptoms and invading the kidney from without, arise independently of tissue of the adrenal cortex. The pathology of these tumors is given in detail.

This excellent résumé is illustrated by the reproduction of 3 roentgenograms and 11 photomicrographs.—*J. H. Harris.*

Wulff, Helge B. Urography in 125 cases of acute renal and abdominal conditions. *Acta radiol.*, 1935, *16*, 77–87.

The author discusses the urographic results obtained in 125 cases of acute abdominal conditions. Eighty patients were examined during the acute symptoms and the remaining 45 within two days after the cessation of acute symptoms. Illustrative roentgenograms are given.

He found urography of very great value in diagnosing acute cases of nephrolithiasis, especially if the examination were made during an attack of pain. In that case minute concrements in the urinary passages, especially the ureters, can be shown much better by urography than by any of the earlier methods. Urography has not yet given satisfactory results in cases of acute pyelitis but with an improved technique adapted to this special condition more detailed information should be obtained in the future.

Urography is of great value in differential diagnosis between kidney disease and other abdominal complaints.—*Audrey G. Morgan.*

Hellmer, Hans. On the technique in urography and the roentgen picture in acute renal and ureteral stasis. *Acta radiol.*, 1935, *16*, 51–55.

The author makes a distinction between cases in which it is desired only to determine whether or not there is stasis, in which case function is observed, and cases requiring a detailed indication of the size and shape of the kidney pelvis, in tumor, tuberculosis, etc., in which case the anatomy is studied. In the former group of cases serial examinations are made at intervals adapted to each individual case. The examination may be extended for several hours, for as much as twenty-four hours if necessary. No compression is used in studying function.

But where the anatomy is to be studied artificial stasis is produced by external compression of the ureters. The compression cushions ordinarily used in examination of the digestive tract are used, the size and shape being varied to suit the patient's bodily structure. By means of this compression the picture of stasis of the kidney pelvis and ureter can be produced and studied experimentally in man. Illustrative roentgenograms are given.—*Audrey G. Morgan.*

Åkerlund, Åke. Ein typisches Röntgenbild bei Konkrementbilding in einer Ureterozele. (A typical roentgenogram in concrement formation in a ureterocele.) *Acta radiol.*, 1935, *16*, 39–42.

The author reports 2 cases of urinary calculi projected into the bladder shadow. Roentgenograms are given. Intravenous urography showed a clear zone surrounding the calculus, indicating that there was a sac surrounding the stone and projecting into the bladder. On this basis, a roentgen diagnosis was made of calculus inside a ureterocele sac, without any knowledge of the cystoscopic findings and in spite of the fact that the intravenous urogram showed no contrast filling of the ureterocele itself in either case. The roentgen diagnosis was verified by operation in both cases.—*Audrey G. Morgan.*

Knutsson, Folke. The roentgen appearance in ureteritis cystica. *Acta radiol.*, 1935, *16*, 43–47.

Chevassu has devised the best method of roentgen examination of the morphology of the ureter. He introduces the olive-shaped tip of a catheter into the mouth of the ureter after which the fluid is injected. The tip of the catheter prevents the fluid from returning and so the ureter is completely filled. This method is relatively new and it is the only one that makes examination of the mucous membrane relief of the ureter possible. Few cases of cystic ureteritis have been described in the literature because until this method was introduced there was no way of demonstrating them. The author describes and illustrates 2 typical cases. There were many small round filling defects lying close together, indicating a nodular mucous

membrane relief. There were no changes of a similar nature in the kidney pelvis.—*Audrey G. Morgan.*

Soiland, Albert, and Lindberg, Ludwig. Plastic induration of the penis. *Am. J. Cancer*, June, 1934, *21*, 372–375.

Plastic induration of the penis is an infrequent lesion, which consists of a firm nodule or plaque appearing spontaneously in the penis, apparently independent of previous pathology. It may be single or multiple, round or oval, with a smooth surface and regular, well-defined margins. The indurated areas usually occur dorsally in the median line or septum, or laterally in the corpora cavernosa. The induration consists of dense connective tissue with a few small blood vessels.

There are two clinical types of the lesion: one involves the superficial tissues above the tunica albuginea and is usually single in the midline of the dorsum of the penis; the other is deep in the tissues and affects the septum, or the lateral portions of the corpora cavernosa, where it is frequently bilateral. The first type is superficial and can be treated surgically; irradiation, preferably with radium, is the treatment of choice in the second type.

Patients having this condition range from forty to sixty years of age. The process is insidious in onset, the nodule slowly increasing in size. There is no pain or tenderness in the induration, but erection is incomplete and rather painful, the penis becoming angulated with the concavity of the curvature being toward the side of the lesion. Coitus may become impossible. There is usually obstruction to ejaculation.

Six cases have been treated in the authors' clinic. All symptoms were eradicated in 3, there was improvement in 2, and 1 recent patient is definitely improved but still under treatment. Radium has been the treatment of choice in the cases, the dose varying from 400–600 mg-hr., usually divided into about two doses several weeks apart; 1 mm. of brass with 2 mm. of rubber was the usual filter.—*Wendell C. Hall.*

Chambers, H. The histological classification of cancers of the uterine cervix and the relation between the growth structure and the results of radium treatment. *Am. J. Cancer*, Jan., 1935, *23*, 1–15.

A study was made of 678 cases of cancer of the cervix treated at the Marie Curie Clinic since it began its work in 1925. Clinical records were studied to find if any special clinical feature could be co-related with the particular histological type. The study was done more particularly to determine to what extent, if any, the response of malignant tumors to irradiation varies as to their histological structure.

The author made a few variations from the commonly accepted classification of tumors. Grade I contains the typical cases of adult common type of squamous carcinoma. The habit of forming stratified epithelium is practically lost. Keratinization sometimes occurs—squamous or cell pearls are a feature. Grade II includes tumors composed of spindle cells resembling those of the basal germinating layer. Grade III includes all cases showing a clear tendency to form stratified epithelium and contains four subgroups, according to the extent of differentiation. In the subgroup "keratinized," the surface layers are transformed into sheets of keratinized squamous. In the subgroup, "differentiated," most of the cells farthest from the basal layers are transformed into squamous but without keratinization. A basal layer can usually be distinguished. In the subgroup, "transitional," the architecture of the epithelium is most like that of the normal mucous membrane of the cervix and vagina. In the subgroup, "anaplastic," although there is still a formation of stratified epithelium, the cells have lost their squamous characters and mitosis can usually be found in all layers. Grade IV includes all the anaplastic growths which show no formation of stratified epithelium. This grade is divided into "4A" where the cells are arranged in alveolar masses with a fair amount of intervening tissue and into "4B" where the tissue is a solid mass of cells and simulates sarcoma.

There was some indication that the anaplastic growths were more common in younger women. Otherwise there was little difference between histological grade in the various age periods.

There was no particular relationship between the duration of symptoms and the type of growth.

In judging the relative radiosensitivity of the tumors the effect of the irradiation upon the primary tumor alone can be considered. This is so because extension into the surrounding tissue cannot be adequately irradiated as

compared to the local lesion. The author's method of treatment does not lend itself to very satisfactory evaluation of the radiosensitivity of the tumors. The plan was to give all the irradiation the surrounding healthy tissue would stand. Cases were considered locally cured when there had been no return of local symptoms and when no growth had been found in the uterus or vagina after two years.

There was very little difference in the results between the various histological grades, the best results being obtained in Grade III, transitional (73.8), and in adenocarcinoma (72.9). The importance of the clinical stage of the disease was very great. None of the histological grades showed a difference of more than 15 per cent in either local cure or in the number of three year survivors. There was no evidence to show that adenocarcinomata are insensitive to irradiation.—*J. H. Harris.*

NERVOUS SYSTEM

Lönnerblad, Lars. Eine Komplikation bei Myelographie. (A complication in myelography.) *Acta radiol.*, 1935, *16*, 56–58.

A case is described and illustrated in which lipiodol given by lumbar injection for the purpose of myelography apparently entered the venous plexus on the posterior side of the bodies of the vertebrae. There is a certain danger of embolism in cases in which the contrast medium enters the veins.—*Audrey G. Morgan.*

SKELETAL SYSTEM

Dyes, O. Das Röntgenbild des Wirbelkanals bei Rückenmarkstumoren und Ostitis fibrosa. (The roentgenogram of the spinal canal in spinal cord tumors and in osteitis fibrosa.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Nov., 1934, *50*, 482–490.

The expansion produced by tumors of the spinal cord or metaplastic increase in bone density which narrows the spinal canal can be recognized by measuring the distance between the vertebral arches. Extramedullary tumors produce greater expansion of the spinal canal and more flattening of the inner contour of the arches than do intramedullary tumors. This finding is not an early one and is of value only in a positive sense. The absence of expansion does not prove the non-existence of a spinal cord tumor. Myelography can be dispensed with in only a few cases because by it 80 per cent of tumors in the operable stage can be recognized.—*E. T. Leddy.*

Eliason, E. L., and Ferguson, L. K. Epiphyseal separation of the long bones. *Surg., Gynec. & Obst.*, Jan., 1934, *58*, 85–99.

Epiphyseal separations are described as fractures, in which the line of fracture lies wholly or in part in the epiphyseal line. They are often associated with a fracture at the end of the diaphysis. When the separation is complete the periosteum is frequently torn from the diaphysis for a considerable distance. The epiphyses are attached to the shaft by dense periosteum and the blood supply to the epiphysis is obtained chiefly from the periosteal arteries. This accounts for the comparatively infrequent occurrence of necrosis of the epiphysis. As the child grows older the epiphyses become increasingly irregular and greater trauma is necessary to produce a separation and reduction becomes increasingly difficult.

Subjective symptoms of epiphyseal separations are frequently not marked. Swelling and ecchymosis may be slight, crepitus when present is soft or muffled, preternatural mobility is hard to obtain. The history of an injury, persistent point pressure tenderness at the site of the epiphyseal line, and disability in motion of the adjacent joint are the most important diagnostic features clinically. Roentgen examination is of little diagnostic help in the very young, in whom there is no ossification of the epiphyseal center. Those separations, which occur after a well-formed epiphysis is present, can be diagnosed roentgenologically by displacement of the epiphysis or an accompanying splitting off of the diaphyseal end of the bone. In many cases a roentgen diagnosis is possible at a later date when signs of calcifying callus make their appearance.

Union practically always takes place and occurs as in fractures, except usually with less callus formation. In most instances in which a single epiphysis forms the joint surface, partial reposition of the epiphysis was followed by normal subsequent growth; this is particularly true of the lower end of the radius. Perfect reposition is most desirable in those areas where several ossification centers are involved in the formation of the entire epiphysis, since subsequent growth produces increasing deformity. This is particularly true of these injuries about the elbow.

Contrary to the usual teaching, the authors

believe that premature ossification of the epiphyseal cartilage occurs comparatively rarely following epiphyseal separation. The degree of reduction is not a factor in premature ossification of the epiphyseal cartilage. The extent of the epiphyseal injury cannot always be determined at the time of the injury. Perfect reposition of the displaced epiphysis does not necessarily insure subsequent normal growth, consequently the prognosis while usually favorable should be guarded.

Epiphyseal separation of the *lower radius* occurs almost as frequently as do fractures in injuries in the region of the wrist occurring during the growing period. This is the most frequent site for epiphyseal separation, being involved in 48 of the authors' 110 cases. Displacement is usually posterior and there is usually an associated fracture of the styloid process of the ulna. There is usually an associated wedge-shaped fragment off the posterior cortex of the diaphysis. Any patient in the epiphyseal age having a fracture of the ulnar styloid should be suspected of having an epiphyseal separation of the radius whether or not it is shown on the roentgenogram.

Separation of the *lower epiphysis of the ulna.* This is the third most common site, constituting 9 of the 110 cases. It rarely occurs alone, usually being associated with an injury to the lower end of the radius. Displacement is usually posterior.

Epiphyseal separation at the *lower extremity of the humerus.* The joint capsule is attached above the epiphyseal line, so as to enclose all but the internal epicondyle. About 40 per cent of injuries about the elbow in the epiphyseal age are separations of the epiphyses, 60 per cent being fractures.

The internal epicondyle is the most frequently involved about the elbow, constituting 24 of 110 cases. This serves as origin of many of the flexor muscles and consequently is displaced downward. The ulnar nerve passes around this epicondyle, and involvement of this nerve is common in separations of the epicondyle. This nerve involvement is characterized by a numbness or loss of sensation in the ulnar distribution of the hand.

The less frequently involved sites are fully discussed but further elaboration here is not warranted since the above 3 sites constitute 93 of the authors' 110 cases.—*J. H. Vastine.*

TATUM, JULIANNA R. Familial cleido-cranio dysostosis. *Am. J. M. Sc.*, Sept., 1934, *188*, 365–371.

Familial cleidocranial dyostosis is described in this study and 4 cases occurring in siblings are reported. The changes noted by the author involve the clavicles, the bones of the skull, phalanges, and the teeth. There is definite delay in development of the osseous skeleton. In the family studied by the author the condition has been present in three generations. The disease is not limited to either sex. It does not, as a rule, produce symptoms of any consequence. This fact may account for the relative infrequency in observing these cases. In adults with this disease, the author states that the blood phosphorus and calcium show normal values, while in children there is a distinct diminution in the blood phosphorus.—*G. W. Chamberlin.*

CONWELL, H. EARLE. Syphilis of the clavicle: report of five cases. *South. M. J.*, Jan., 1935, *28*, 11–16.

Syphilitic involvement of the clavicle is often confused with other pathological conditions, such as tuberculosis, malignancy, Paget's disease, and chronic osteomyelitis. Stokes is quoted: "The first approach to bone lesions must be medical and diagnostic rather than surgical and therapeutic, if serious blunders with respect to syphilis are to be avoided." The diagnosis is based upon a consideration of the history, the roentgen findings, the serological reaction and the response to specific therapy. Conway is quoted: "The radiograph has proven invaluable in the diagnosis, not only because of early recognition, but also because of its demonstrating the repair processes occurring after the institution of specific therapy. A myriad of diverse roentgenological findings occur, dependent upon the stage of evolution of the process. Two pertinent and outstanding facts should be noted: first, lues of the bone is usually a constructive osteoplastic process, and second, the extent of the recorded roentgen involvement in lues of the bone is rarely paralleled by the clinical symptoms, the clinical findings not being as extensive as the radiographical evidences. Distribution may be localized in any part of the bone or diffuse throughout the bone. Radiographically, the changes are striking within a short period after

the institution of treatment." The desirability of serial roentgenograms must not be overlooked in the differential diagnosis. Five case reports are presented, of which two were bilateral. Al responded to specific therapy.—*W. R. Brooksher.*

Novati, Giulio Calchi, and Cossali, Cesare. Di una caratteristica alterazione delle dita delle mani nei mungitori. (Characteristic changes in the fingers of milkers.) *Radiol. med.*, Jan., 1935, *22*, 27–38.

Twelve cases are described and illustrated with roentgenograms in which characteristic changes were seen in the fingers of men whose work was milking. The changes were chiefly in the joint between the last two phalanges of the index and middle fingers of both hands; in some cases the ring finger was also deformed, but not the thumb and rarely the little finger. The joint heads were deformed, flattened and enlarged; there were osteophytes in the peripheral part of the joints and a marked subluxation. The terminal phalanx was flexed toward the palm and complete flexion and extension were impossible. The lesions did not cause any pain and did not interfere with the work of milking though they might have interfered seriously with other forms of work. This was a chronic deforming arthrosis which began in the soft parts and extended to the joints later. The subluxation of the terminal phalanx on the next phalanx preceded the joint changes, which is contrary to the picture seen in ordinary arthroses and arthritides. The lesions were apparently purely mechanical as examination of the rest of the skeleton in these cases did not show any evidence of any diathesis or infection which could have been a contributory cause.—*Audrey G. Morgan.*

Milch, Henry. Osteoid-tissue-forming tumor simulating annular sequestrum. *J. Bone & Joint Surg.*, July, 1934, *16*, 681–688.

In a report appearing in 1930, Hitzrot described an unusual case which he considered "a sclerosing osteomyelitis of the carpal scaphoid," though he was not certain that it should be considered "a sclerosing type of bone tumor." After Hitzrot's report, Milch was able to observe and collect in his practice, 4 cases which were similar in history, clinical findings, roentgenographic examination and histological study. The symptoms are pain, swelling, and the latter may or may not be associated with heat and redness of the overlying skin. The pain is of a dull boring character, worse at night and after exertion. Erroneous diagnoses of Brodie's abscess, tuberculosis, or a sclerosing osteomyelitis are often made.

The roentgen appearance, at first glance, may suggest an annular or button-like sequestrum lying free in a cavity. However, in the first stage of the process, the central area is quite uniformly dense. As the lesion progresses, this central portion seems to be subdivided into a peripheral annular zone of radiopacity, surrounding a central lighter area which may represent the site of tumor necrosis. Beyond the central area there is a zone of radiotranslucency, which is traversed by radially arranged opaque striations, which seem to unite the central area with the surrounding bone. This is the bone of osteoid tissue which, being calcium-poor, naturally offers but slight barrier to the passage of the roentgen rays. Still more peripherally lies normal bone which may be faintly outlined or which may be sharply demarcated from the zone of osteoid tissue by a dense circular shadow. At the outset, the lesion is localized sharply to the uninvolved bone. As time goes on, the surrounding tissues seem to be involved in the reactive process.

The lesion appears to belong to the class of benign osteoblastic osteoid-tissue-forming tumors. The possibility of malignant transformation exists, though it is not clearly established. The treatment should be complete excision.

The lesion was situated in Milch's 4 cases in the radius, in the neck of the astragalus, in the fibula and in the last case in the phalanges of the toe. In 3 of his cases there was a history of previous injury which presented a medicolegal interest. It is his opinion that the injury is not related to the development of the tumor. —*R. S. Bromer.*

Goriainowa, R. W. Zur Frage der Heredität der Ektrodaktylie. (The inheritance of ectrodactylia.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Sept., 1934, *50*, 289–294.

Goriainowa presents the roentgenographic findings in two generations of a family in which ectrodactylism and syndactylism occurred and points out the importance such studies may have in the field of genetics. He feels that this deformity is definitely hereditary and follows Mendel's law.—*E. T. Leddy.*

Bruno, G. Über senile Strukturveränderungen der proximalen Humerusepiphyse. (Senile structural changes in the proximal epiphysis of the humerus.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Sept., 1934, *50*, 287–289.

The author studied the changes in the architecture of the proximal epiphysis of the humerus at various ages and compared them with the roentgen findings. Rarefaction of the spongiosa appears first at about the age of forty in the greater tuberosity, extends with age toward the head of the humerus and stops at the epiphyseal line. These changes can be exactly followed roentgenologically.—*E. T. Leddy.*

Pokorny, Lilly. Die Kienböcksche Erkrankung des Mondbeins und ihre Stellung im Rahmen der entschödigungspflichtigen Berufskrankheiten. (Kienböck's disease of the semilunar bone in realtionship with industiral diseases.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1934, *49*, 566–587.

Keinböck's disease of the semilunar bone is a traumatic necrosis of the bone lamellae. It occurs almost exclusively in the more used hands of those doing heavy labor who carry out the same repeated motion—force dorsoflexion—of the hand. It is most common in miners and so should be included in the list of occupational disease of that occupation. Twelve cases are presented of which two types are differentiated, a malignant and a benign group. The prognosis varies with the type and the correct treatment for it may be outlined accordingly. The histories and roentgenograms of these 12 cases are discussed.—*E. T. Leddy.*

Whitman, Armitage, and Lewis, Raymond W. Non-tuberculous infections of the spine. *J. Bone & Joint Surg.*, July, 1934, *16*, 587–593.

Tuberculosis of the spine and chronic osteoarthritis or spondylitis are usually recognizable with a fair degree of certainty by their roentgenographic appearance, and the clinical and roentgenographic diagnoses can usually be made with considerable assurance. Other known types of infection of the spine are osteomyelitis, typhoid arthritis, lues, Neisserian infection, fungus infections, undulant fever and unclassified infectious arthritis. Whitman and Lewis believe that only with considerable difficulty and uncertainty can these be recognized and classified roentgenographically and clinically. They report 4 cases which they believe to be non-tuberculous spine infection. The cases are reported in detail with roentgenographic findings. The first seemed to be either (1) a case of that broad and inclusive group called infectious arthritis, organism unknown, following what has been called, for lack, perhaps, of a better name, intestinal influenza; or (2) a case of the osteomyelitis group. The second case seemed to belong to the unclassified infectious arthritis group. The third, was probably a case of low grade pyogenic infection with abscess of the vertebral body. In the fourth case, there was a history of boils prior to onset of the spinal symptoms, and this suggests the possibility of a chronic non-tuberculous osteomyelitis and arthritis.—*R. S. Bromer.*

Burman, Michael, Weinkle, Isaac N., and Langsam, Maurice J. Adolescent osteochondritis of the symphysis pubis, with a consideration of the normal roentgenographic changes in the symphysis pubis. *J. Bone & Joint Surg.*, July, 1934, *16*, 649–647.

Disease processes seldom involve the symphysis pubis, and of those that do, only traumatic diastasis of the symphysis has been adequately described. Tuberculosis or osteomyelitis is rare. Occasionally after a suprapubic cystotomy, a suppurative osteochondritis (osteomyelitis to all intents) may appear. The region of the symphysis is also occasionally involved in tumor metastasis, but the symphysis itself seems to be spared.

The authors report the case of a young man, aged seventeen, who suffered a severe trauma, pinned between a slowly moving truck and a fence. No roentgenograms was made at the time, although urged, because of financial reasons. Four and one-half months later, a secondary disease process had apparently appeared in the symphysis pubis. A roentgenogram showed an irregular, woolly appearance of the symphysis pubis, with an excess of the mammillation noted in many symphyses at this age period. There were several free bone fragments in the space of the symphysis itself. The process seemed to be more advanced on the right side. A roentgenogram, taken about nine and one-half months after the initial trauma, showed almost complete subsidence of the disease process within the symphysis pubis. The latter was, however, definitely irregular.

A study of 127 roentgenograms of normal symphyses was made. A full, detailed account of the normal appearance at all age periods is given by the authors. In only 2 cases was there seeming fragmentation as in the case they report. They conclude that the changes in their patient were due to a growth disturbance at an age period when ossification was active but incomplete. The original trauma probably injured the blood supply. They infer the pathological changes are an aseptic, subchondral necrosis, comparable to the pathological process observed in other osteochondritides although this conclusion is open to criticism as no specimen was available for examination. They think many cases must pass unrecognized, both symptomatic and asymptomatic. Roentgenographically the symphysis pubis heals in such a manner that there is more irregularity of the symphysis than is the usual case.—*R. S. Bromer.*

Pickett, J. C., and Harbin, Maxwell. Osteochondritis of the growth centers. *Surg., Gynec. & Obst.*, June, 1933, *56*, 1000–1008.

Despite the large number of cases of osteochrondritis recorded in the literature there has been an almost complete absence of pathological studies. Three cases are presented in which tissue has been removed by the "Key block method" and histological studies made. One case is of particular interest in that the condition was generalized, apparently involving all of the epiphyses. In 1 case four positive cultures were obtained, all containing *Staphylococcus albus*. The third patient was of particular interest in the rapid subsidence of the clinical signs and symptoms following immobilization, the prompt return upon active motion and rapid subsidence upon subsequent immobilization. The pathological changes observed in all 3 cases were similar in that the cartilage, both articular and epiphyseal, was the seat of the most striking alteration. The osteoporosis of the epiphysis could be explained by the inactivity, rather than as a feature of the disease. The asymmetry and non-development (apparent destruction) of the head seemed better accounted for as a failure in new bone formation, rather than as a destruction of already formed bone. The cause of the cartilaginous degeneration was not apparent, although faulty nutrition is suggested. Microscopic evidence of inflammation was not seen in either bone or cartilage.—*J. H. Vastine.*

Graziansky, W. Die Kaschin-Becksche Krankheit im Röntgenbilde. (The roentgenologic picture of Kaschin-Beck's disease.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Oct., 1934, *50*, 367–376.

The author (in Leningrad) studied 9 children from East Siberia aged nine to seventeen years with this disease and in this paper he illustrates many of the roentgen findings he obtained. He says three stages may be differentiated: the primary, that of active development and that of deforming osteoarthritis. The best guide for this differentiation is the degree of change in phalangeal joints of the small bones of the wrist. Chondrodystrophy resembles this disease closely. The disease which is a specific lesion of the epiphyseal and joint cartilages may stop in stages 1 or 2 with residual premature synostoses of the cartilages or, later, a polyarthrosis. Since Kaschin-Beck's disease may be arrested by change in the habitat of the patient without any other treatment, early recognition of the disease by roentgen examination is of greatest importance.—*E. T. Leddy.*

Carpenter, George K. A pathologic basis for the disabled back. *J. Tennessee M. Ass.*, Jan., 1935, *28*, 8–13.

The lesions of the intervertebral discs as causal factors in back disabilities are discussed. Disc injury is not revealed by roentgenograms, but the resulting vertebral changes produce characteristic roentgen findings. The most frequent manifestations of intervertebral disc injury are: (1) retropulsion of the nucleus pulposus into the spinal canal: (2) prolapse of the nucleus pulposus into the adjacent vertebral body: (3) localized vertebral osteoarthritis: (4) generalized vertebral osteoarthritis: (5) thinning of the intervertebral disc, with or without wedging of the vertebral bodies, and (6) biconcave vertebral bodies and spherical discs.—*W. R. Brooksher.*

Boyd, Douglas. Knee-joint visualization; a roentgenographic study with iopax. *J. Bone & Joint Surg.*, July, 1934, *16*, 671–680.

Thirty per cent iopax, dissolved in a 0.5 per cent procaine solution was used to visualize knee joints in a small number of cases. This solution did not cause serious reactions and was quickly absorbed from the joints. The solution used produced a hyperemia of the synovial membrane, but no cellular exudate. The most serious reaction noted was increased pain for

forty-eight hours. No patient had symptoms of fever; none noted any local redness at the puncture site or joint area. In none of the patients did the pain last longer than seventy-two hours. Three of the 7 patients had relief from the previous joint pain and effusion for from two to six months.

Boyd states that a larger acquaintance with the roentgen appearance of knees injected by this method must be had before giving a dogmatic interpretation of the roentgenograms. He believes the method has diagnostic value, particularly in separating the chronic arthritis knee from these joints which might more readily yield to surgical treatment, namely, the doubtful displaced cartilages, loose bodies, the true hypertrophic synovitis, and erosions of the weight-bearing surfaces of the cartilage. It may also be of value in the diagnosis of early syphilitic and tuberculous joints, as well as in a more complete study of certain old traumatic conditions of the knee. With more experience in studying roentgenograms of such injected knee joints, he thinks he will be able to read more clearly the positive and the negative shadows that give a composite picture of the outline of the synovial sac and the contours of the joint cartilages.—*R. S. Bromer.*

D'Aunoy, Rigney, and Connell, John H. Osteitis fibrosa localisata of the patella. *J. Bone & Jone Surg.*, July, 1934, *16*, 689–694.

The authors report a case of osteitis fibrosa localized to the patella, their case being the third on record of this condition. The roentgen examination revealed an irregularly shaped area of opacity in an expanded thin-walled patella, and a tentative diagnosis of giant cell tumor was first made. The patella was removed at operation and the microscopic sections revealed osteitis fibrosa. They believe the process is a pathological complex, dependent upon altered osteoblastic-osteoclastic activity, and conservative treatment is indicated.—*R. S. Bromer.*

Rothberg, Abraham S., Feldman, Joel W., and Schuster, Otto F. Congenital fusion of astragulus and scaphoid; bilateral: inherited. *N. York State J. M.*, Jan. 1, 1935, *35*, 29–31.

A case of bilateral congenital fusion of the astragalo-scaphoid joint with the same roentgen findings in the patient, her brother and their mother is reported. This is the first and only case on record with definite hereditary factors. —*W. R. Brooksher.*

Davidson, Leonard T., and Merritt, Katharine K. Viosterol in the prophylaxis of rickets in premature infants; clinical, chemical and roentgenologic observations. *Am. J. Dis. Child.*, Aug., 1934, *48*, 281–308.

In this study, the authors made a comparison of clinical, chemical and roentgenologic evidence of the development of rickets in a group of premature infants who received no antirachitic therapy from birth to the age of five months. No significant variation of serum calcium or inorganic phosphorus from birth to five months of age was observed, even in the presence of severe clinical and roentgenologic rickets. Viosterol 250 D in a maximal dosage of 20 drops a day was inadequate for the complete protection of the premature infant. No influence of the rapidity of growth on the severity or the rate of development of the rickets was observed. Low serum calcium values, when found, tended to occur in infants in who osteoporosis was shown by roentgenograms; but no close correlation could be established between the serum calcium level, the degree of osteoporosis and the severity of craniotabes.

The diagnosis of rickets has been possible at a considerably earlier age by the roentgenogram than by clinical evidence in the majority of cases. The authors describe a sign hitherto undescribed, rarefaction and fraying of the radial surface of the proximal end of the shaft of the ulna, which has been an early and significant sign of rachitic involvement in the premature infant. This often was apparent at the age of six weeks, before the appearance of signs in other portions of the bones. Marked osteoporosis, periosteal proliferation and thickening of the cortex also were found to be characteristic of early rickets. The tendency to osteoporosis seems to be probably due to a deficient store of calcium at birth in the premature infant and to an insufficient absorption of calcium throughout the early months, together with a rearrangement of the bone calcium which results in a withdrawal of calcium from the trabeculae and a deposition within the marginal cortex. Periosteal proliferation manifests itself at first as a general thinning and haziness of the lateral margins of the shaft and can often be demonstrated only by reading back from later films, in which the

proliferated periosteum is sharply outlined by a heavy deposit of calcium. In the authors' experience, this process has often accompanied continued activity, before antirachitic therapy has been instituted. They regard the roentgenogram as the criterion of prime importance in the early diagnosis of rickets.—*R. S. Bromer.*

Anspach, William E. Xanthomatosis with involvement of a vertebral body. *Am. J. Dis. Child.*, Aug., 1934, *48*, 346–354.

Anspach states that while the "punched-out" areas found on roentgenograms of the skull produced by lipoid infiltrations of the reticuloendothelial system have been reported in the literature many times, roentgen evidence of the course of an analogous lesion of the spine with clinical findings of xanthomatosis has not been reported. He reports such a case which is of interest from the diagnostic standpoint. The early histologic interpretation favored myeloma and the clinical diagnosis was Pott's disease. His summary follows:

"A case presenting the clinical picture of xanthomatosis, as previously outlined by Rowland, is described. The patient came to the hospital because of an acute pain in the back. A roentgenogram showed what seemed to be a compressed vertebral body. These findings led to an early diagnosis of Pott's disease. Many nodules on the head appeared on the roentgenogram as circumscribed areas of decreased density of the skull tables. The usual histologic appearance of one of the nodules led to an interpretation favoring a myeloma. The child made a rapid and apparently complete recovery and has remained well since (nine years). In view of all the findings it was concluded that a diagnosis of xanthomatosis was more warranted than one favoring other forms of lipoid infiltrations, neoplasm or tuberculosis.

"The main points of interest in this case are: (1) involvement of a vertebral body, successive roentgenograms and clinical observations taken over a long period suggesting the nature of the process; (2) the absence of characteristic foam cells in the tissue examined, and instead, a manifestation of a late stage consisting of marked infiltration of eosinophilic leukocytes; (3) prompt and apparently complete recovery without roentgenray or other special treatment."

The case is reported in detail together with illustrations of the serial roentgenograms showing the course of the disease in the tenth dorsal vertebra.—*R. S. Bromer.*

Kaplan, Emanuel B. Multiple fractures associated with blue sclera. *J. Bone & Joint Surg.*, July, 1934, *16*, 625–630.

Kaplan reports a new therapeutic measure in the treatment of multiple fractures associated with blue sclera and the result of an investigation of the character of the blue discoloration of the eyeball.

In the family of one of his patients, it was found that in all female members the fractures ceased after the normal onset of the menstrual cycle. Because of this finding, the administration of ovarian hormone to little girls suffering with multiple fractures was attempted, and injections of a soluble extract were given once a week over a certain period. Unfortunately, the treatment could not be continued because one family moved to a different town and the other patient, after a series of twelve injections, refused treatment on account of pain. During the period of injections no fractures occurred and the patients felt much better.

In the investigation of the character of the blue sclera, a solution of eserine was instilled into the eyes of the patients in one series of cases and one of atropine in the eyes of another series. It was thought that, if the blue discoloration were due to increased transparency the contraction or dilatation of the vessels of the uvea and tunica choroidea would influence the intensity of the discoloration. No changes in the discoloration of the sclera were found in either series. The reactions of the pupils were normal. In contrast to these observations, it was found on several occasions that the intensity of the bluish discoloration of the sclera varied without apparent reason. Kaplan concludes that the contention that the color of the sclera is due to an abnormal transparency needs further confirmation.

The therapeutic response to the ovarian gland extract in his cases, the favorable results obtained by Ryan with the use of thymus extract, the peculiar roentgen appearance of the bones, not unlike that found in parathyroid disease, the early appearance of centers of ossification, and in one of his cases, the early finding by competent clinicians of a thymus affliction, lead Kaplan to favor an endocrine disturbance as a possible explanation of brittle bones. At present the hereditary form of brittle bones with blue sclera is classified as a hereditary hypoplasia of the mesenchyma. A few factors, however, do not seem to be in full

agreement with this generalization.—*R. S. Bromer.*

COMPLANI, MARIO. Contributo alla conoscenza radiologica delle lesioni scheletriche in corso di linfogranuloma maligno. (Roentgen study of the bone lesions in malignant lymphogranuloma.) *Radiol. med.*, Jan., 1935, *22*, 39–46.

In malignant lymphogranuloma of the Hodgkin-Sternberg type there may be granulomatous foci in the bones similar to those in the glands. The author describes a case in a man of thirty-one who in 1929 after a period of fever developed swelling of the glands of the neck and also those of the inguinal region and mediastinum. He improved greatly on 12 treatments with roentgen rays. In 1930 there was again enlargement of the glands, including the peritoneal glands. Roentgen treatment again gave good results. In 1931 he had fever and vague pains in the limbs. A biopsy at this time showed typical Sternberg lymphogranuloma. The patient was obliged to go to bed because of a spastic paretic condition of the lower limbs. Roentgen examination at this time showed almost complete destruction of the 7th dorsal vertebra. Nothing was left but a small wedge of bone. The other vertebrae were not affected but other bones showed destruction of the bone marrow; such foci appeared in the head of the right humerus, in the right scapula and the left humerus. The diaphysis of this bone showed zones of bone atrophy with a peculiar "gnawed" appearance. There were also foci in the right ilium and in the femurs. In some of these localizations there was a defensive periosteal reaction. Definite differentiation from other destructive bone lesions is not possible on the basis of the roentgen picture alone. Roentgen treatment was again given in this case with good effect but the patient died about six months later in a violent attack of fever.—*Audrey G. Morgan.*

PERLMAN, ROBERT. Sarcoma formation in Paget's disease of bone. *J. Bone & Joint Surg.*, July, 1934, *16*, 594–603.

Perlman found that sarcoma formation is of relatively frequent occurrence in Paget's disase of bone, but case reports with a careful histological examination are infrequent. In his case the correct diagnosis was made by microscopic study, but, unfortunately, clinical and roentgenographic data were not very complete. The sarcomatous lesion occurred in the lower end of the femur, and, apparently at the same time in other areas. The histological picture of the tumor varied from polymorphonuclear sarcoma to spindle cell sarcoma and fibrosarcoma. The tumor led to pathological fracture at the lower end of the femur, and to invasion of the cavity of the knee joint and of the popliteal vein, with sarcoma metastases in the lungs.

Osteitis fibrosa seemed to be the predisposing cause of the tumor growth, because only those portions with very mature fibrous bone marrow showed tumor formation, whereas the parts with looser bone marrow and younger bony changes, in the sense of Paget's disease, were not affected by tumor growth. Careful examination of the microscopic sections showed that the presarcomatous stage described by von Albertini, is not necessary in sarcoma formation in the bone marrow of Paget's disease. In some cases reported, and also in Perlman's case, a multicentric tumor growth apparently took place.

The roentgenograms of the affected knee joint showed the typical changes of Paget's disease, and in addition a destructive lesion on the anterolateral aspect of the femur, lower end. The cortical bone in this area was markedly destroyed and the focus was surrounded by almost eburnated bone tissue. The intra-articular fracture of the lateral condyle was readily seen in the anteroposterior view.—*R. S. Bromer.*

HSIEH, C. K., MILTNER, LEO J., and CHANG, C. P. Tuberculosis of the shaft of the large long bones of the extremities. *J. Bone & Joint Surg.*, July, 1934, *16*, 545–563.

Tuberculosis of the shaft of the large long bones of the extremities is reported as a lesion rare in Occidentals. Attention, the authors say, has not been called previously to its more frequent occurrence among the Chinese. They report 20 cases, all of which showed lesions included in the definition of Hildebrandt, Zumsteeg and Caan, namely, those originating in the diaphysis and metaphysis, excluding those in the shaft which represent an extension of the disease from the epiphysis or from the joint.

They divide the lesions into four types according to their roentgenographic appearance, basing their classification on the location and extent of the lesions:

Type 1—Tuberculous periostitis. This is the

rarest form of shaft tuberculosis. It is characterized by rarefied, laminated new bone in the periosteum over an apparently intact cortex.

Type II—Solitary tuberculous abscess (rodie's type). This form is represented by a single area of destruction, usually located centrally in or near the metaphysis. The abscess may or may not be well circumscribed. In the early stages, there is relatively little condensation around the periphery, but in the later stages it is usually surrounded by dense bone. Sometimes sequestra are present. Late in the course of the disease, the destructive process may involve the surrounding bone by direct invasion, and then it becomes impossible to distinguish this type from others.

Type III—Localized tuberculous osteomyelitis. In this form a larger portion of the shaft is involved. Early in the disease, the medullary and cortical portions of the bone appear hazy and decalcified, with scattered areas of rarefaction and destruction. After many months, the destroyed areas of the medullary region show sharper lines of demarcation, and the cortex shows irregular areas of destruction and condensation. When the superficial layers of the cortex and the periosteum are involved, there is usually a certain amount of involucrum present, which, although less in amount and less dense and homogeneous, may be very similar to that found in pyogenic osteomyelitis. Later in the disease, after sinuses have developed externally, the roentgenographic findings are frequently confusing, because of the added factor of secondary infection which usually simulates involucrum formation. In cases with mixed infection, the periosteal new bone often presents a very irregular outer surface, with fringy, serrated, or radiating projections of involucrum.

Type IV—Massive tuberculous osteomyelitis. During the early stages of this lesion, roentgenograms show marked decalcification of the shaft, usually with a fusiform swelling of the periosteum and surrounding soft tissues. As a rule, in this type the circulation of the periosteum is not seriously affected, and therefore, laminated layers of involucrum may be seen after several weeks or months. At this time, the cortical and medullary bone of the shaft shows extensive decalcification, with many scattered areas of destruction.

The authors encourage the use of early exploratory operation. They also make routine examinations of the lungs. Patients with shaft tuberculosis do not usually respond well to treatment. In many of their cases, secondary infection seemed to have a favorable influence upon the healing of tuberculous shaft lesions. This, they explain on the basis of an increased fibroblastic reaction of the soft tissues, as a result of which the tubercles become walled off and quiescent.—*R. S. Bromer.*

Simmons, Channing C. Primary malignant bone tumors; differential diagnosis. *Am. J. Surg.*, Jan., 1935, *27*, 19–25.

This article cannot well be abstracted and should be read in its entirety by every general surgeon and radiologist.—*W. R. Brooksher.*

Palugyay, J. Zur Ätologie und Röntgendiagnostik der Knochensarkome nebst einem Beitrag zur Osteoarthropathie hypertrophiante pneumique. (The etiology and roentgen diagnosis of bone sarcoma and some remarks on osteoarthropathie hypertrophiante pneumique.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Aug., 1934, *50*, 107–120.

Palugyay reports a case in which after a trauma there developed the symptoms of osteomyelitis of the right femur. Several months later the lesion acted like a sarcoma. Enucleation produced an apparent cure. After fourteen months metastasis took place to the mediastinal nodes with bronchostenosis and atelectasis in the right lower lobe: at the same time the typical picture of osteoarthropathic hypertrophiante pneumique.

The author attempts to explain the etiology of the sarcoma from facts drawn from the series of roentgenograms made in the case and from the clinical and biopsy findings. He takes the view that the traumatic damage to an occult chondroma started its sarcomatous degeneration. This broke down and became infected so that osteitis resulted. The differential diagnosis of osteitis from benign and malignant bone tumors is discussed. Finally, the symptomatology and etiology of the osteoarthropathy are discussed in relation to this case.—*E. T. Leddy.*

BLOOD AND LYMPH SYSTEM

Knapp, John C. Arteriography. *N. York State J. M.*, Jan. 15, 1935, *35*, 76–78.

Thorium dioxide in 25 per cent solution, diluted with an equal amount of normal saline, has been used as the radiopaque agent. The procedure is of definite diagnostic value in the

vessels of the extremities but there are many possible errors in interpretation. The interpretation depends upon: (1) congenital anomalies; (2) changes in the vessel lumen from a very slight constriction to complete occlusion; (3) extent of collateral circulation at the point of occlusion; and (4) presence of dilatations or aneurysms.—*W. R. Brooksher.*

GENERAL

Warren, Shields, and Witham, Eva M. Studies on tumor metastasis. 2. The distribution of metastases in cancer of the breast. *Surg., Gynec. & Obst.*, July, 1933, *57*, 81–85.

No other common cancers show as wide distribution of metastases as do those of the breast. The authors' study is based on 162 autopsied cases of breast cancer. The cases are divided into three groups on the basis of their histological appearance. 1. The least differentiated is the carcinoma simplex, in which the tumor is growing in solid masses or cords of cells without alveolar formation. This tumor may be either scirrhous or medullary in its local lesion and metastases. There is no significant variation in the behavior of the scirrhous and medullary types. This group is prone to metastasize early and the prognosis is less favorable. 2. The adenocarcinoma is more highly differentiated. The cells of the primary tumor are arranged in definite alveoli and the metastases are usually so arranged. 3. The most highly differentiated group is the colloid carcinoma, characterized by the presence of a great amount of mucinous secretion, the absence of early metastases, a relatively limited distribution of late metastases, and as a rule a very large local lesion.

There were 5 which could not be classified, 2 epidermoid carcinomata arising from Paget's disease, 1 lymphoblastoma and 1 undifferentiated sarcoma.

The duration from the onset of symptoms was 3.1 years for carcinoma simplex, 3.2 for adenocarcinoma, 6.5 years for the epidermoid carcinomata and 8 years for the colloid carcinomata. The most frequent sites of involvement are distant lymph nodes, lungs, liver, bone, regional lymph nodes, skin, pleura, adrenal glands, etc. The cases autopsied showed a total of 781 organs or tissues involved. The only tissues which were spared were the eye, middle ear, pineal body and nasopharynx. The great majority of bone metastases are hematogenous and are of the osteoclastic type, the lumbar vertebrae and the upper ends of the femora being most frequently involved. About 50 per cent of the cases showed metastasis to bone and in two-thirds of these there were associated pulmonary metastases.—*J. H. Vastine.*

ROENTGEN AND RADIUM THERAPY

Dubowyi, E. D., Grinberg, N. A., Prodan, M. T., and Gefter, O. W. Anwendung der Röntgenstrahlen bei Diphtheriebazillenträgern und bei Diphtheriebazillenausscheidern. (The use of roentgen rays in the treatment of diphtheria carriers and diphtheria spreaders.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Sept., 1934, *50*, 294–299.

The increase of diphtheria and its mortality make the problem of combatting this disease very acute. In the active methods of combatting the disease, besides the active immunization of actual patients, the question of bacilli carriers comes to the foreground. The usual methods of treating carriers, quarantine, medical, surgical and physical measures are insufficient particularly at the time of an epidemic which usually produces a high percentage of carriers. The authors (from Odessa) report favorable results in 75 cases after a single treatment. They used a Stabilivolt apparatus, 210 kv., 4 ma., 0.5 mm. Cu+2 mm. Al at a focus-skin distance of 25 cm. to fields over the nose and the tonsillar region about 4×5 cm. in children and 5×6 cm. in adults; up to the age of five they gave each field 20 per cent s.e.d., from five to ten years 25 per cent s.e.d., from ten to fifteen years 30 per cent s.e.d., and after that age one-third s.e.d. (s.e.d. = 640 r) in a single session. The results are important from an economic point of view in that the period during which the dangerous patient is isolated in quarantine or hospitalized is shortened. The problem of diphtheria carriers is so important that the application of roentgen rays should be tested more extensively.—*E. T. Leddy.*

Schmiedt, E. Myxödem bei einem Röntgenologen. (Myxedema in a roentgenologist.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1934, *49*, 593–597.

This is the report of a roentgenologist who developed myxedema, a likely effect of roentgen rays on his poorly protected thyroid. Examination of his blood showed a condition that was interpreted as a roentgen anemia and so that roentgen rays produced myxedema at the same time seems likely.—*E. T. Leddy.*

Sturgis, Somers H., and Lund, Charles C. Leukoplakia buccalis and cancer. *New England J. M.*, Jan. 3, 1935, *212*, 7–9.

A critical study was made of 25 patients who developed malignancy of the mouth or lip while under treatment for precancerous lesions of the same areas to determine the significance of etiological factors in the development of buccal cancer. Age, sex, syphilis, the use of tobacco and poor dental hygiene, widely recognized as of etiological importance, were found to be of no value in predicting the likelihood of the development of cancer in a case of premalignant disease. The incidence of cancer in leukoplakia of the buccal mucosa was found to be definitely higher than that in premalignant lesions confined to the lip. Duration was not a factor. An appreciable increase in cancer incidence was found in premalignant lesions of greatest extent. Preventable factors, found primarily dependent upon the personal equation, were delay in reporting, inadequate treatment and error in diagnosis. A second group of factors, not controllable in the present state of knowledge, were early metastasis, extent of premalignant lesion, high grade of malignancy of tumor, and multiple foci. In this series the factors of the first group were of more importance in the prognosis.—*W. R. Brooksher.*

Watson, William L. Carcinoma of the esophagus. *Surg. Gynec. & Obst.*, May, 1933, *56*, 884–897.

Carcinoma of the esophagus causes between 3 and 4 per cent of all cancer deaths. The author has seen 506 cases of carcinoma of the esophagus in which there was a positive biopsy in 267. About 50 per cent occurred in the lower third. The incidence is greater in males (84.3 per cent to 15.7 per cent in females). About 18 per cent are radiosensitive. Of the 267 cases, there were 243 squamous cell lesions, 19 adenocarcinomata and 5 of the transitional cell type.

The disease is rapidly fatal, the average length of life being ten and a half months from onset of symptoms. There is probably insufficient time for widespread dissemination since metastasis had only occurred in 52 per cent of 13 cases coming to autopsy. Death was due to bronchopneumonia in 48 per cent of the cases.

Treatment by any method is discouraging, as evidenced by the author's statement that a cured case will continue to be a medical curiosity. Surgery is of value only in a few selected cases.

Intraesophageal irradiation, both surface and interstitial, have been tried. Guisez reported 30 patients living more than eighteen months of 270 treated by radium capsules introduced in a bougie, about 6,000 milligram-hours being so administered in two weeks. The insertion of gold filtered radium emanation seeds directly into the tumor has given only indifferent results. Watson recommends routine gastrostomy combined with extensive irradiation through four portals, cross-firing the lesions, directing the rays so far as possible to avoid vital structures giving a total of 2,000 r through each portal.—*J. H. Vastine.*

Haenisch, G. F. Über die Wachstumsschädigung des Knochens und die Entwicklungshemmung der weiblichen Brustdrüse nach Röntgenbestrahlung im kindlichen und jugendlichen Alter. (Interference with growth of bone and with the development of the breast as a result of roentgen irradiation in childhood and youth.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1934, *50*, 78–86.

After a survey of the literature, Haenisch reports a case of true limitation of bony growth of the arm following roentgen irradiation of a young girl two and one-half or three years old for a tumor of unknown nature in the right upper arm. The factors of the evidently intensive treatment (8) are not stated. The patient herself noted at the age of twelve that her whole right side was less developed than the other. In addition to the faulty development of the arm there was a marked failure of the right breast to develop like the other. From the evidence that Haenisch presents this must be regarded as a true roentgen injury and not a change due to any bone disease. Pictures of the patient and roentgenograms of her arm substantiate Haenisch's opinion. He feels from his checkup of published evidence that some of the conclusions from animal experimentation need considerable modification for application to man.—*E. T. Leddy.*

Gilbert, Judson B. Carcinoma of the male breast. *Surg., Gynec. & Obst.*, Oct., 1933, *57*, 451–466.

Male breast cancer comprised 1.24 per cent of admissions to the breast clinic and 0.14 per cent of all cancers in males. Bailey, at the London Hospital, upon examination of male breasts of post-mortem subjects between the ages of six months and sixty-five years, found glandular tissue present in all cases. Since

glandular tissue is present normally, the male breast as a site for the development of carcinoma is not surprising.

The author reports on 47 cases and quotes Wainwright, who collected 418 cases from the literature in 1927. Attention is called to the frequent association of gynecomastia and carcinoma of the breast in the male—19 per cent of the author's cases having a gynecomastia in addition to other endocrine disturbances. A five year survival of 11.5 per cent is reported. Radiation therapy is recommended as a valuable adjunct in the operable group and of great value as a palliative measure in the inoperable cases. Heavier dosage in irradiation methods is recommended.—*J. H. Vastine.*

D'Emidio, Angelo Santoro. La radiumterapia nelle metastasi ossee da carcinoma mammario. (Radium therapy in bone metastases of carcinoma of the breast.) *Radiol. med.*, Nov., 1934, *21*, 1286–1297.

Bone metastases are one of the most frequent and serious complications of cancer of the breast. The moment a patient who has been operated on for cancer of the breast feels the slightest pain in any of the bones a roentgenogram of the whole skeleton should be made. If solitary lesions are discovered early treatment is quite hopeful. And even in late cases with multiple lesions treatment prolongs life and relieves pain. The most frequent sites of bone metastases are in the following order: the vertebrae of the dorsolumbar segment, the sacrum, the bones of the pelvis, the proximal segments of the femurs, the dorsal and cervical vertebrae, the ribs, the cranium and the diaphyses of the long bones. Not infrequently bone metastases appear while the nodule in the breast is yet small and has not been discovered.

The author treats these bone metastases with radium which he finds in some respects superior to roentgen rays. He makes a flexible apparatus of gauze which can be applied to the affected part. He used a total of 80–100–150 mg. radium. On using only gamma rays with suitable filtration there is no danger of radium necrosis. There are two forms of bone metastasis, one osteoclastic and the other osteoplastic. The former is much more radiosensitive than the latter. The radium is applied for a period of ten to twenty days—the shorter period in metastases of the spinal column and the longer one in metastases of the femur, for instance, when the bones are covered with a thick layer of muscle. The irradiation is repeated after an interval of two months. After the first treatment the pain stops, there is reconstruction of bone and if there are pareses or paralyses they gradually disappear.—*Audrey G. Morgan.*

Bloodgood, Joseph Colt. Value of preoperative irradiation in bone tumors. *Am. J. Surg.*, Jan., 1935, *27*, 35–42.

Every suspicious lesion of bone should receive, even before biopsy, a course of irradiation, either by deep roentgen rays or by 4 gm. radium pack. If no distinct improvement follows this course, exploration or aspiration biopsy should be performed. While the sections are being studied, a second course of irradiation may be given. The technique of aspiration biopsy and the dangers of immediate operation are discussed. Illustrative cases are reported.—*W. R. Brooksher.*

Coley, William B. Endothelial myeloma or Ewing's sarcoma. *Am. J. Surg.*, Jan., 1935, *27*, 7–18.

The author favors an extrinsic or microbic etiological factor because of (1) the frequent association with antecedent local trauma, (2) the close similarity to osteomyelitis, both clinically and roentgenologically, and (3) the frequent association of a rise in temperature. Results in 115 cases warrant the following conclusions: (1) Irradiation should be abandoned as the primary method of treating operable endothelial myelomas of the long bones, except in the presence of some condition that renders amputation inadvisable. (2) While the brilliant results of conservative treatment (toxins and irradiation) in a number of cases of inoperable endothelial myeloma, some with extensive metastases, would seem to justify an attempt to save the limb in early operable cases, the actual results of conservative treatment have been so poor that the author does not feel warranted in its continuance. (3) The results of surgery alone cannot be determined from this series as such a method has not been employed in a single case. (4) While the group treated with toxins alone shows the highest percentage of five year cures, the majority of these cases were treated elsewhere, and the failures have not been reported. (5) The author believes that the results obtained by early amputation followed by prolonged treatment with Coley's toxins would seem to justify his regarding this as the method of choice.—*W. R. Brooksher.*